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The PROGRESSIVE FISH-CULTURIST

News and Views from many Sources on Practical Hatchery Problems

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PEACE AND THE P. F. C.

ONE OF THE BEST KNOWN figures in American history is the Minute Man of Concord, rifle in hand as he stands beside his plow. The most casual observer knows that when the peril is passed, the man's attention will return to the plow.

Publication of the PROGRESSIVE FISH-CULTURIST was suspended immediately after Pearl Harbor. Fish, as a food and as a source of relaxation, were important to the waging of the war, but the national emergency permitted little or no attention to improvement and conservation. Many of our men left their fishery problems, taking up more urgent duties in the far corners of the world.

Were the Minute Man of Concord to return to his plow today, he would be bewildered by new problems. Similarly, the men returning to peacetime pursuits after the recent hostilities are aware of the time lost, the need to pick up loose ends, the desirability of pooling and weighing new thought. Publication of the PROGRESSIVE FISH-CULTURIST is resumed to bring to the men in the field--hatcherymen and biologists interested in fishery management--information regarding the latest developments in all phases of their work. With this in mind, the Division of Fishery Biology (which previously published the PROGRESSIVE FISH-CULTURIST) and the Division of Game-fish and Hatcheries have joined forces to present the new PROGRESSIVE FISH-CULTURIST, in which it is planned to offer articles dealing with fish culture, fishery research, and fishery management in fresh water.

Nature and scope of the new PROGRESSIVE FISH-CULTURIST will be determined to a large extent by the cooperation of its readers. Its purpose will be served best when the men for whom it is published regard it as their own medium of exchange for ideas, problems, and even controversy.

The Editors.

Mr. Albert M. Day

NEW DIRECTOR OF THE FISH AND WILDLIFE SERVICE

ALBERT M. DAY, who on April 1, 1946, succeeded Dr. Ira N. Gabrielson as the Director of the Fish and Wildlife Service of the Department of the Interior, is a veteran of 27 years of service with the former Bureau of Biological Survey and the Fish and Wildlife Service.

Born in Humboldt, Nebraska, in 1897, Mr. Day nevertheless considers himself a Wyomingite, as his family moved to a ranch in that State in 1900. In this very rugged country his early interest in fishing and hunting and the out-of-doors developed rapidly. His major studies at the University of Wyoming (B.S. in 1922) were animal husbandry and biological sciences.

During the first World War Mr. Day was in the Signal Corps. Returning to civilian life, he entered the Bureau of Biological Survey in 1919 as a temporary field assistant in rodent-control work in Wyoming. He became leader of rodent-control work in Wyoming, and 2 years later, then a junior biologist, he served as district leader in the Wyoming-Nebraska district. On July 1, 1928, he became associate biologist and to his duties in rodent control added the assignment of directing the activities of professional hunters to protect Wyoming livestock and game from wolves, coyotes, and bobcats.

Attracting attention by his very successful performance in these early assignments, Mr. Day was transferred in 1930 to Washington, D.C., to assist in the administration of the Division of Predatory Animal and Rodent Control. At this time Mr. Day's practical experience in control operations was of great assistance in the preparation of his "Handbook for Hunters of Predatory Animals," which is still a major source of information--instructions, methods, and policies--for the guidance of predator hunters under the supervision of the Service. Another contribution that is still very effective in the Service's program is the trap spring that Mr. Day designed for use under the pan of a trap in order that it might not be sprung easily by birds or by small furbearing or other beneficial animals.

When the Division of Predatory Animal and Rodent Control was combined with the Division of Game and Bird Conservation 4 years later to form the Division of Game Management, Mr. Day was placed in charge of the Predatory Animal and Rodent Control Section.

The passage of the Pittman-Robertson Act--probably the most important wildlife conservation measure since the passage of the Migratory Bird Treaty Act in 1918--made possible Federal cooperation with the States in wildlife research and restoration, permitted new concepts of Federal-State relationships in the management of this resource. To administer this new work the Federal Aid Division was formed in 1938, and Mr. Day was appointed as Chief of the new Division. The success and popularity of the Pittman-Robertson projects--involving wildlife management research, land acquisition, and developmental programs--have been due in large measure to the fine groundwork achieved under Mr. Day's skilled leadership.

Early in 1941, when President Roosevelt requested that a liaison officer from the Fish and Wildlife Service be appointed to cooperate with defense agencies, Secretary Ickes designated Mr. Day for this additional task. When the Service was decentralized and moved to Chicago in August 1942, Mr. Day remained in Washington to act as the agency's liaison officer. Following the retirement of Assistant Director W. C. Henderson in November 1942, Mr. Day was selected as his successor. Since that date Mr. Day has been largely responsible for the field administration of the Service's vast and complicated operations. His appointment as Director of the Service represented the logical choice for continuance of the extensive program to which he had already contributed in large degree.

Mr. Day's activities have by no means been restricted to the bounds of his own organization. An enthusiastic fisherman, for a number of years he has given valued service as a national director of the Izaak Walton League of America and has followed with interest the proceedings of the American Fisheries Society. Until recently chairman of the Committee on Employment in the Wildlife Society, he is now a member of the Advisory Committee of the Wildlife Society. Mr. Day has been a frequent contributor of articles to various sportsmen's magazines and periodicals, and the Outdoor Writers' Association of America is proud to claim him as one of its members. He is also a member of the Biological Society of Washington.

Mr. Day's appointment as Director of the Service may be regarded as recognition of outstanding executive capacity, as well as unusual ability in the inauguration of new work. His extensive experience as a specialist on various types of assignments in all parts of the country, has given him first-hand understanding of conservation problems. The conservation world may look to the future with confidence.

The Editors.

AVAILABLE KNOWLEDGE AS A SPUR TO PRACTICAL FISH CULTURE

C. M. McCay
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Ithaca, New York

THREE HUNDRED YEARS AGO men discovered that no one developed scurvy if he took liberal amounts of orange and lemon juice. But the knowledge was not used extensively until modern times. As a result, in the intervening years thousands of men were tortured by rotting gums and legs for weeks before they passed to the next world. When they arise on Resurrection Day, about the first thing they will have to do will be to hunt a dentist and get a set of false teeth because most of their own were lost from their rotting gums before they died.

The knowledge of how to prevent such suffering was in the world, but only a few men knew it.

One of the most important services that can be rendered today is to translate knowledge into simple terms so that everyone in the fish hatcheries and conservation service can understand it. Such translation is no easy task since the man who does it must understand the science he reads and have the practical knowledge to sift out facts that may be useful to the practical man in the hatchery.

In our world today there is a vast knowledge that remains unused. Part of this information is buried under foreign languages such as Russian or old Latin that relatively few men can read. Even those who can read these languages often render little help because they have so little knowledge of applied science or theory that they do not really understand words after they are translated. Furthermore, there is much buried knowledge. Half the chemistry known in America is supposed to be buried and hidden in the files of large industries which keep it secret in the interest of their own profits. Another large reservoir of knowledge is hidden because various governments feel it has importance in time of war.

Aside from this unavailable knowledge there is a vast field of information that would be useful if concentrated so that the man working in the hatchery could read and understand it. Making this available is one function of this publication and one reason why we wrote the first 19 numbers of Notes for the Progressive Fish Culturist (which started in October 1933 and developed as the present-day PROGRESSIVE FISH-CULTURIST).

A publication like this should contain articles that not only summarize current discoveries but also keep digging back into the ocean of early science. Useful knowledge is much like a jig-saw puzzle of a fish: a good picture of the tail of a fish may have been made a hundred years ago; the body may have been described fifty years ago; the best picture of the head may appear today. To complete the puzzle we need all parts of the body. This is true of science. Often observations have been made and lost for a century. At the time they were made, they seemed to have no use. As other parts of the puzzle are provided, the whole can be assembled and put together.

For these reasons the true scientist is constantly reviewing the literature of the past and hitching it to modern discoveries to make a working team that is useful. The study of the discoveries of the past as well as of those of the present is a means by which a man can acquire the wisdom of old age without getting gray hairs and a bad heart.

In addition to the literature of science that needs constant scrutiny, there is a vast body of unwritten information that should be exchanged. Men should not hesitate to present information even if they stopped school in the sixth grade. They may have useful facts that others desire.

The other day we overheard a man with little reading knowledge telling a woman how to prevent her Great Dane puppy from breaking windows and climbing on furniture. He told her to buy some mouse traps and set them on the window ledge and on her prize sofa. This method may or may not have been printed in books. Nevertheless, it is simple and valuable knowledge.

One of the assets of the early numbers of the Transactions of the American Fisheries Society was the printing each year of the discussions verbatim. To some superficial scientists these may have seemed trivial, but in many respects they were superior to the technical articles. The printed discussions recorded the state of knowledge of men handling practical problems; they described long years of valuable personal experience and observation; often they deviated from the subject under discussion, but they presented problems for exploration in basic science at the same time. A way must be found for a return of this exchange of knowledge between the practical man and the scientist in order to advance through mutual understanding.

It must be remembered that our whole science in trout culture really goes back to the labors of a couple of French fishermen who probably could neither read nor write. They worked out the methods of fertilization of trout eggs, and these methods were later studied and put into practice by French scientists. An untrained man often makes such first advances because he is not prejudiced in believing that something is impossible. Therefore, independent of degree of education, everyone should be encouraged to describe his experiences in a field such as fish culture.

SCIENCE AND FISHERY RESEARCH

Progress in fishery science has been unduly slow because of the employment of only a few classes of specialists in attacks upon problems. There is genuine

need to obtain the services of many scientific disciplines in order to bring various bodies of knowledge to bear upon problems. The failure to enlist the services of diverse scientists is due to (1) the ignorance and lack of perspective of the specialist himself in regard to his ability to contribute to basic problems in the fishery field, and (2) the inability of administrators to visualize the possibility of the application of other disciplines.

The specialist often fails to appreciate these basic problems. Furthermore, he is liable to be treated as a stepchild by the fishery field itself because workers in this field often cannot understand his language or thoughts. Such scientists as physicists or chemists must always face the loss of caste among their fellow specialists if they enter a borderline field. Colleagues tend to throw the mud of incompetence charges at the man who enters a borderline field. Between the mud-throwing of specialists in a given science on one hand and that of traditional workers already employed in the field, a new type of specialist is liable to be made rather unhappy if not ultimately starved to death. Nevertheless, specialists in borderline fields have unique opportunities to make marked contributions toward advancement.

Fisheries research is especially lacking in this diversity of scientists because of the early predominance of men like Jordan and Evermann. These workers excelled in the description and classification of fish. Such science is useful and must always be maintained. However, it is only a small part of the picture when living fish are concerned. Fish culture deals with living fish. Life in ponds, streams, and lakes is concerned with the physics and chemistry of water and light. It deals with both plants and animals. To name and describe these is far from sufficient either outdoors or in the hatchery. At the same time, naming and describing are an essential part--but only a part--of the jig-saw puzzle of living matter.

The most rapid advance in all phases of fish culture, ecology, and conservation will be made when the labors of groups of diverse scientists are employed. Needed are chemists, physicists, biochemists, physiologists, pathologists, nutritionists, embryologists, and many other specialists. With these in active service advances of undreamed proportions can be made.

Not only must such scientists be employed, but they must be assured of security and permanence of position. All scientists must be given equal consideration in regard to salaries and advancement, whatever the specialty.

In employing such specialists the most difficult problem is that of the administrator in making the selection. Knowing little of specialized fields outside his own, he is subject to deception by that small group of pseudo scientists who make great promises but never deliver results. Year by year such men promise only to forget the past and make new promises as time passes.

The only way to protect any field of applied science from such fakes is for the administrator to use boards of consultants to assist in the selection of specialists, to pass on the merit of projects and the scientific value of results obtained. Boards of consultants from a specialized field can usually protect an agency. This is essential because a charlatan or poorly qualified specialist yields nothing in research and, therefore, discredits the specialty that he is supposed to represent.

Finally, if it is to yield results in any field, research must be performed by free men. Few scientists who start bravely and industriously to labor after they have completed their training, can resist destruction if they find themselves enmeshed in red tape and harassed by petty dictators in the form of clerks or unimaginative, stereotyped administrators. In our age we have witnessed many potential scientists marched to the slaughterhouse, where they were encased in red tape and their life work sterilized in frustration. No one profits nor desires this, so a way must be found to prevent it in the interest of advances in all fields of biology.

SUMMARY

(1) A brief attempt has been made to describe the functions and assets of any publication that helps make modern science more available for use in fishery research.

(2) Much more rapid advances are possible in the future if biological sciences will enlist the service of diverse specialists such as chemists, nutritionists, physicists, and physiologists.

(3) Scientists in research must be carefully selected and then given a maximum of freedom to pursue problems in the manner they see fit.

THE PROGRESSIVE FISH-CULTURIST

Originally the PROGRESSIVE FISH-CULTURIST appeared as monthly numbers of a serial memorandum, Memorandum I-131. Beginning with No. 1 in December 1934, the PROGRESSIVE FISH-CULTURIST appeared at various intervals during succeeding years until publication was suspended with No. 56 in December 1941 for the duration of the emergency.

Publication is resumed with Vol. 9, No. 1, January 1947. The next issue is expected to appear in March 1947; thereafter, publication will be by quarter. For greater convenience, pagination will be continuous throughout a volume.

RIVER DEVELOPMENTS

AND THEIR EFFECTS UPON

FISH AND WILDLIFE RESOURCES

Rudolph Dieffenbach
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Fish and Wildlife Service
Chicago, Illinois

THE DEVELOPMENT of hydroelectric power, the storage of water for irrigation and flood control, and the canalization and impoundment of rivers for navigation, proposed by the Corps of Engineers, United States Army, and by the Bureau of Reclamation, Department of the Interior, for almost every section of the United States, will have important effects on the fish and wildlife resources of the Nation. The extent and nature of this influence will depend upon the degree of success of the programs of these agencies and upon the contributions made by the Fish and Wildlife Service and by the State conservation departments.

Because of the importance of the areas that may be destroyed or affected by the developments, the Fish and Wildlife Service, as the national representative of the conservation interests of the country, recognized the need to take the lead; to seek the help of the several States in the study of these development plans; to find means to lessen fish and wildlife losses; and likewise to propose methods which would improve such resources. Authority for doing this is found in the Coordination Act of 1934 (48 Stat. 401) and is now very clearly strengthened by a revision of that act, approved August 14, 1946, and entitled "An Act to Amend the Act of March 10, 1934, entitled, 'An Act to promote the conservation of wildlife, fish, and game and for other purposes'."

In considering this problem, the Service is not entirely interested in the esthetic importance of the fish and wildlife resources of the Nation but takes a practical point of view to determine what effect these developments will have upon the economy of the Nation. Such a practical approach is necessary under the prevailing circumstances. The basis for this statement is that the river developments planned by the Corps of Engineers and the Bureau of Reclamation are measured in terms of money. Their projects stand or fall after having been measured by such a yardstick. Therefore, in order that the findings of the Fish and Wildlife Service can be expressed in understandable terms by the sponsors of the projects and by the Congress of the United States, the Service puts its findings in terms of dollars and cents.

Too many times in the past, fish and wildlife have lost when in conflict with economic interests. As a matter of fact, fish and wildlife are resources of great economic value. More than 20 million people in the United States hunt and fish for recreation. They spend for equipment and transportation approximately two billion dollars each year. Most of this money goes into local communities and to small industries. Part of it supports State and Federal agencies charged with protecting and maintaining fish and game animals. The food value of the fish and game taken annually (exclusive of commercial fishing) exceeds one-half billion dollars. The Service recognizes that, in addition to these values, there are large esthetic values which cannot be stated in dollars and cents. As circumstances warrant, this fact is pointed out in the reports on river-basin projects.

In considering the river-basin development plans, it is necessary to emphasize the obvious fact that dams are permanent and will result in permanent changes in the surroundings. Thus, the estimates of existent fish and wildlife values of a project must be based on the fact that a resource lost now is lost forever. It is for this reason that the fish and game resources are studied during the planning stages of every project. Delay might result in unnecessarily large losses or failure to obtain maximum benefits.

The Fish and Wildlife Service is under obligation to prepare survey reports on fish and wildlife values concerned in river-development projects. These reports are submitted, after proper review, to the sponsoring agencies and become parts of their official survey reports submitted to Congress. The information thus becomes a part of the economic assessment of cost and benefit and influences the decision of Congress with respect to authorization of projects. Because of the large number of projects and the urgency of submitting reports early, the Office of River Basin Studies, a special organization of the Service, was established in 1945.

The River Basin Studies organization has four types of technicians. They are wildlife biologists, fishery biologists, hydraulic engineers with biological background, and cover-type mappers, who make maps of the plant cover on project areas. Each of these groups has responsibility in the field and office for specific parts of the work. The Office of the Coordinator of River Basin Studies guides the operations from the headquarters of the Fish and Wildlife Service in Chicago. The Chicago staff is composed of wildlife and fishery biologists and hydraulic engineers. The field staffs are attached to the five Service regions and to a special region known as the Missouri River Basin. The latter is confined to this watershed and takes in parts of Service regions I, II, and III, with headquarters at Billings, Montana. The River Basin Studies staff of each of the regions is like that of the Central Office. The duties of a regional staff are mainly field studies and the writing of reports; whereas the functions of the Central Office staff are administrative, including the final review of reports prepared in the field.

At the beginning of the work, one of the most difficult problems was to lay down a sound basis for the monetary evaluation of sport fish and game. There were almost unlimited variations in personal opinions, as well as wide regional differences. Such literature as was available on these subjects was studied. The game departments of the States were asked for their advice and statistical

support for the values estimated by them. The guiding rule used in setting up unit values (per pound of fish or per game animal) was the average cost to sportsmen in taking them. For commercial fish, the primary sale price was used. The values thus determined are used as the base values by the field biologists, who are instructed to change these values as local conditions warrant. As our field experience and the variety of work conditions increase, the base values are modified, but it is an interesting fact that the values laid down at first hold up well in the face of criticism. By the same token, as experience increases, techniques are improved, more skill is displayed, and more assurance is felt in the results obtained.

The evaluation before construction requires a census of the population of fish and game, and determination of the annual yield of all important species--both game and commercial. The estimation of value which will exist after construction demands a most careful study of the engineering plans to determine the probable conditions and yields after impoundment. The value of a project, both before and after construction, can be determined by multiplying the yields by the unit values. The recommendation of the Service on each project is based on the net effect on fish and wildlife, whether a loss or a gain in dollar value. Whether the recommendation is favorable or unfavorable, suggestions are made for changes in structures or operation which will tend to decrease the losses and increase the benefits. These suggestions may involve establishment of a dead-storage pool, creation of subimpoundments, control of water levels during the spawning season of fish and the nesting season of waterfowl, purchase of nearby lands for management of game, and the like.

In addition to the studies of the immediate areas to be flooded, investigations are made on lands to be irrigated and on streams below dams. The latter investigations include consideration of the seasonal downstream flows, the volume of water released, and the manner in which it is released. In considering the effects on fish and wildlife on irrigable lands and the ditches that service them, investigators take into account probable benefits or damages to fish and wildlife that will result from the use of the canals. Also taken into account is the effect on habitat by silt, oxygen content, salinity, pollution, temperatures, and other conditions.

Exclusive of the Pacific coastal rivers--notably the Columbia, Sacramento, and San Joaquin Rivers--the problem of migratory fish has not yet offered difficult problems for the Service. It generally has been unnecessary to recommend fish ladders or additional fish hatcheries; but where such are needed, the Service puts a proper recommendation in the report.

Supplemental fish and game data are obtained from various sources. Some of the most valuable are the State conservation departments, State universities, and Government agencies, such as the Forest Service, Soil Conservation Service, and the Indian Service. Other fruitful sources of information are the State geological, water, park, and historical agencies.

The Fish and Wildlife Service always seeks and receives full cooperation from officials of the State conservation departments, who are invited to participate in the field investigations. Completed field reports are reviewed with State

conservation departments and with the sponsors in order to be sure that the coverage is accurate as to basic material obtained from them, and that the reports are consistent with State responsibilities in the matter of fish and wildlife. After the reports have been reviewed in the field, they are likewise reviewed by the several Divisions of the Service in the Central Office to make certain that the various interests of the Service are properly weighed. Each report is concluded with the series of recommendations justified on the basis of the studies that have been made.

The aim is to develop the best methods for using the facilities that are being created. The reservoirs are viewed from the standpoint of their future use for the production of sport and commercial fish, as State or Federal migratory waterfowl refuges, and as public shooting grounds. For the highest usefulness of the impoundments in the interest of conservation, it is the duty of the Fish and Wildlife Service to devise means to increase fish and wildlife habitat through changes in the operation of reservoirs, trying always to keep within practicable bounds in so doing. The same observation generally applies to the lands, canals, and ditches which make up the irrigated areas. In many instances, it can be expected that, with the adoption of these recommendations, a project can be changed from the loss to the gain side of the ledger. Also, the Service sometimes recommends that experts of the Division of Fishery Biology and the Division of Wildlife Research, in cooperation with the States, make long-time studies which will lead to proper management of the resources after the project is built. Only the combination of suitable conditions and good management will produce and maintain maximum fish and game crops on the land and water areas to be created by the development of the Nation's rivers.

QUESTION DEPARTMENT

What's bothering you? What's your pet problem?

If you'll just speak up about your troubles, you may find that they used to trip up someone else--till he found the flashlight. No use stubbing your toe in the dark by yourself. Dropping a line to the PROGRESSIVE FISH-CULTURIST about your question is guaranteed to bring you more concrete results than the lurid language that follows a barked shin.

SEVERAL EGRETS TOO MANY

The sale of egret plumes has been prohibited for some time. Recently, however, at some hatcheries in the Middle West the birds appeared to be presuming upon this protection. Large numbers of egrets took quite a heavy toll of fish at the Genoa (Wisconsin) and Guttenberg (Iowa) hatcheries, especially when the ponds were being lowered and the water was shallow.

FURUNCULOSIS

AND ITS TREATMENT

James S. Gutsell
U. S. Fish and Wildlife Service
Kearneysville, West Virginia

FURUNCULOSIS has been the most dreaded disease of trout hatcheries, not only because of very heavy losses, but also because there has been no curative treatment nor means of preventing its spread through any pond or trough of fish among which it has appeared. Where it has spread through a hatchery, the only sure way to get rid of furunculosis has been to remove all fish, disinfect all ponds and troughs, etc., and restock with healthy fish (Davis, 1937, 1938).

In American hatcheries, brook and brown trout suffer most, but rainbow trout are not immune and may be dangerous as carriers. Salmon and European sea trout suffer heavy losses. Apparently none of the salmonoid fish, if exposed, is safe. Under some conditions the disease is contracted by fish of other groups.

Furunculosis receives its name from the sores, resembling furuncles or boils, which often occur on infected fish. However, not only are fish in early and carrier stages apt to be free from sores, but many, if not most, of those in the most acute phase--when death comes quickly--may be free from these sores.

Although there is no sure diagnosis by inspection (besides the typical open sores), there are a number of symptoms which are cause for alarm. These include: sores not resembling boils but of a characteristic appearance, occurring most frequently at or near the base of the dorsal fin; red patches about the head; bloody areas in the muscle and visible through the skin, at least with fingerlings; a diffuse pinkish coloration, sometimes over nearly all of the fish, caused by minute subcutaneous hemorrhages (petechial hemorrhages); fins which are bloody, especially at the base, and which may be ragged; congestion of the gut, especially the hind gut; and the break-down of tissue, especially of kidney and spleen, into semifluid masses. Frequently trout with the disease in an advanced stage dart about, especially at the surface, in apparent agony. Death follows shortly.

See also:

Carl, C. C.
1939. Furunculosis and another case of ichthyophthiriasis. Prog. Fish-Cult. 45: 47-50.

Fish, F. F.
1935. Bacterial diseases of fish. Prog. Fish-Cult. 5:1-9.

Schneberger, Edward
1941. Fishery research in Wisconsin. Prog. Fish-Cult. 56: 16-18.

For positive identification, either the serological "complement-fixation" test (Blake and Anderson, 1930; Mackie et al., 1933) or bacteriological tests are necessary.

Bacterium salmonicida, the bacterium which causes furunculosis, typically is cylindrical and 3 microns or less in length ("short rod"). It stains gram-negatively, is non-motile and non-sporing, develops on ordinary culture media under aerobic conditions at room temperature, produces a diffusible brown pigment, liquifies gelatin and coagulated serum, and ferments glucose and mannitol but not lactose or sucrose (Williamson, 1930; Mackie et al., 1930, 1935; Duff and Stewart, 1933).

The disease is affected by water temperature. British experiments (Mackie et al., 1935) indicate that death comes most quickly at 15° to 18°C. (59° to 64.4° F.), whereas temperatures of 5°C. (41°F.) or lower and 21°C. (70°F.) or higher are relatively inhibitory

Warming of (cool) water, crowding, and the mingling of carriers with disease-free fish favor the development of outbreaks (epizootics).

There is general agreement that B. salmonicida lives only a few days in pure water, but there is some uncertainty as to how long it may survive in sewage-polluted water, and on mud, moist moss, eggs, etc. (See Plehn, 1924; Williamson, 1928; Mackie et al., 1935; Duff et al., 1940.)

B. salmonicida is highly susceptible to drying.

B. salmonicida is continued through dormant periods by fish known as carriers, which have low and inactive infections, especially of the kidney.

PREVENTIVE AND HELPFUL MEASURES

It is obvious that fish showing symptoms of furunculosis should never be brought to a hatchery nor moved to pools where the fish appear free from the disease. Because trout may harbor the disease and yet appear perfectly sound, no fish (no matter how healthy it seems) should be brought from a hatchery with furunculosis to one where the disease does not occur, nor be moved from an infected pond to an uninfected one.

If eggs and equipment are brought from an infected hatchery, they should be carefully disinfected. At a hatchery where furunculosis is present or suspected in certain pools, troughs, etc., exposed clothing and equipment should be kept apart or disinfected before being put into general use.

HTH or other chlorine solutions of proper strength[1/] are satisfactory for disinfecting metallic and other equipment.

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[1]About 25 p.p.m. of available chlorine is recommended for the treatment of nets and fabrics that would be injured by concentrated solutions. It is important that the nets be well rinsed before treatment. For the rapid disinfection of metallic, wooden, or rubber equipment, much stronger solutions (e.g., those containing about 1 per cent of available chlorine) are harmless, more certain in action, and therefore indicated.

At Leetown it is the practice to dip in a copper-sulphate solution any eggs that may possibly be contaminated. The strength used is 1 part of copper sulphate to 3,000 parts of water (1/3,000) for 1 minute. This is very convenient, but it has not been shown that the copper-sulphate treatment is effective on eggs contaminated with B. salmonicida.

Blake (1930) found a 1/2,000 solution of acriflavine harmless to trout eggs and effective against B. salmonicida in 20 to 30 minutes. Gee and Sarles (1942) reported an acriflavine solution slightly weaker than 1/500, and a sulfo-merthiolate slightly weaker than 1/6,000, effective in 10 minutes. They stated that the senior author had used acriflavine successfully in the treatment of more than 2,000,000 eyed trout eggs, but that they believed that sulfo-merthiolate, used with care, should give the best results of any of the disinfectants they tested. In Wisconsin it is standard practice to disinfect trout eggs for 30 minutes in a 1/2,000 solution of acriflavine brought to a pH of 7.5-8.0 with 100x buffer[2]. A simple and rapid method of proved effectiveness would be a great help to hatcherymen.

EXPERIMENTS AT LEETOWN

In an experiment run in 1945 (Gutsell, ms.), all the brook trout (about 8 months old) in a group suffering very heavy losses from furunculosis were brought into the hatchery and distributed among 15 lower troughs. For assignment of treatments and controls, these troughs were grouped in 3 blocks of 5 troughs. For evidence of possible injurious effects from any of the treatments, a fourth block of 5 troughs was arranged at the opposite end of the hatchery and supplied with 8-month-old brook trout free from furunculosis. The original weight of the fish in each trough was about 16 pounds.

Dr. Frank W. Hachtel, Department of Bacteriology, School of Medicine, University of Maryland, Baltimore, who supplied agar slants and made the necessary cultural tests, confirmed the belief that these diseased fish were infected with B. salmonicida.

The drugs selected for trial were sulfathiazole, sulfamerazine, and "furacin" or "2-20-99" (new drug). Each of these was administered by being mixed with the food. As a fourth treatment, furacin was added to the water of the troughs. The fish of the fifth trough of each block received no drug and served as a control. Treatment was begun on August 30.

Initial losses per trough ranged from 9 to 29 per day. In the controls, mortality continued through the 23 days before gill disease appeared and brought the experiment to a close.

Furacin in the food apparently was beneficial but much less so than the sulfa drugs. Furacin in the water did not appear helpful. On the 16th day sulfanilamide was substituted for furacin in food, and sulfadiazine in the food for the furacin in water. The delayed trial of these drugs was inconclusive but did not suggest that either would be especially effective.

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[2]Letter from Dr. D. John O'Donnell.

Benefit from sulfathiazole seemed definite but decidedly less so than the benefit from sulfamerazine. Though mortalities were light after the 13th day of treatment, they continued through the 23d day and were considerably higher than with sulfamerazine.

Improvement among the fish being treated with sulfamerazine was impressive. After the 12th day there was only one death in each trough: these deaths occurred on the 15th, 16th, and 19th days. The total loss was 17 per cent.

For 2 days the approximate daily dose of sulfa drugs per 100 pounds of fish was 5 grams; for the next 3 days, 6.5 grams; for the next 8 days, 8 grams; and thereafter, 11.5 grams. The 5-gram rate apparently was helpful; the 6.5-gram rate was clearly beneficial; the 8-gram rate was in use when the mortality ceased.

On May 18, 1946, in cooperation with Dr. S. F. Snieszko, a second experiment was begun, this one to test various doses of sulfamerazine (Gutsell and Snieszko, ms.). The fish used were yearling brook trout. Because the number of fish per trough from the infected pool was rather small, other yearling brook trout were added, the same number to each trough.

Because of the mixture of infected and uninfected groups and perhaps also because the fish were yearlings instead of fingerlings, mortality was less rapid and more prolonged than in the first experiment.

The daily doses tried were 4, 8, and 12 grams per 100 pounds (8.8, 17.6, and 26.4 grams per 100 kilograms) of fish. The experiment was run in quadruplicate except that half were fed once a day and half were given food (and in the case of the treated fish, sulfamerazine) at 8-hour intervals. Treatment was discontinued on the 25th day in half of the treated groups and on the 38th day in the others.

In the controls, mortality continued until the 63d day. In all treated lots the mortality dropped to zero by the 15th day and thereafter was almost negligible in amount. Observation was continued until the 69th day.

In reducing daily losses to zero, the 4-gram rate was about as effective as the higher rates. (See Table 1.).

TABLE 1.--Effectiveness of dosages of sulfamerazine

	Controls		4-gram rate		8-gram rate		12-gram rate	
	(A)	(B)	(A)	(B)	(A)	(B)	(A)	(B)
Initial	558	100	558	100	558	100	558	100
15th day	368	66	493	88	505	90	502	90
25th day	301	54	490	88	504	90	493	88
Final (69th day)	225	40	474	85	494	89	481	86

(A) Numbers present
(B) Per cent of original number present

On May 29, 1946, a third experiment was started, also in cooperation with Dr. Snieszko (Gutsell and Snieszko, ms.). The fish used were brook trout fingerlings, about 160 to the pound. Six (6) pounds were placed in each of 12 troughs. The daily doses tried were 2, 4, and 6 grams of sulfamerazine per 100 pounds (4.4, 8.8, and 13.2 grams per 100 kilograms) of fish. The experiment was run in triplicate. The outbreak of furunculosis among these fish, whether because of the virulence of the strain of B. salmonicida or because of the age or size of the fish, was very severe. Furthermore, the experiment was started soon after the start of the outbreak, so that most of the losses occurred during the experimental period.

In two groups receiving each dosage, treatment was discontinued on the 25th day. In the third group receiving each dosage, treatment was continued to the 37th day.

In the controls, mortality continued until the 44th day and resumed intermittently from the 52d to the 63d day.

The 2-gram rate was helpful, but quite evidently it was too light.

With the 4- and 6-gram rates, the daily mortality dropped to zero by the 21st to 27th day, but mortality began again by the 34th day in the group which received the shorter treatment.

Among the fish treated at the 4-gram rate until the 37th day (10 days after mortality had stopped), mortality did not reappear until the 50th day. Thereafter there was light mortality, chiefly of small fish showing infection by B. salmonicida. At least some of these were also infected by Octomitus salmonis.

Among the fish similarly treated at the 6-gram rate, only one dead fish was found to be infected by B. salmonicida.

From an experiment begun in August, it appears that daily dosage at the rate of 5 grams of sulfamerazine per 100 pounds (11 grams per 100 kilograms) of fish has little ill effect on the growth of fingerling brook trout, that 10 grams or more per day per 100 pounds (22 grams or more per 100 kilograms) markedly slows growth, but that even 15 grams per day per 100 pounds of fish generally has no lethal effect. With rainbow fingerlings, on the other hand, even the 15-gram rate seems to have little effect on growth. This indicates that salmonoid species vary considerably in their tolerance to sulfamerazine and that tests should be made, as soon as may be, with brown trout and Atlantic salmon, two species notably susceptible to the disease.

RECOMMENDED TREATMENTS

Sulfathiazole was helpful in the first experiment, but because sulfamerazine was most effective--particularly as with its use mortality disappeared in about 2 weeks--sulfamerazine was first choice for further trials and was recommended for use in the treatment of furunculosis.

Because it was the dose in use when mortality dropped from a considerable rate to zero, 8 grams per day per 100 pounds (17.6 grams per 100 kilograms) of

fish was the dosage rate first recommended. In the hope of eliminating the disease, it was further recommended that treatment be continued for 6 days after mortality stopped.

In mid-July 1946, on the basis of experience and data available at that time, it was recommended that the daily dose be at the rate of 6 grams per 100 pounds (13.2 grams per 100 kilograms) of fish for 4 days, thereafter 4 grams per 100 pounds (8.8 grams per 100 kilograms), treatment to be continued for at least a week after mortality ceased and to extend over a total period of at least 3 weeks.

Later experience suggests that a continuation of treatment at the 4-gram rate even for 10 days after mortality stops is insufficient to eliminate the disease, but that such prolonged treatment is more apt to be effective if at the 6-gram or higher rate. For the present, therefore, it is recommended that the fish be treated at the 6-gram rate (6 grams sulfamerazine per day per 100 pounds of fish) for 10 days after mortality stops, for a total period of at least 3 weeks.

Nearly all the infected fish which die at intervals after mortality generally has ceased, are small and thin. There is danger that such individuals will infect others. Therefore, it is important that such small, thin fish be removed from infected groups as soon as possible.

It should be clear that the rate of 6 grams per day per 100 pounds of fish applies whether it is given in one or more feedings per day. During the period of treatment the fish should receive no food which does not contain sulfamerazine. With yearlings, giving food and drug once a day is sufficient. In order to afford the best chance for every fish to get its share of the drug, it is recommended that the amount of food be nearly all the fish will take, but not more than they will take.

To secure the most even, practical distribution of the drug through the food, the sulfamerazine (powder) should be mixed with the dry feed before that is mixed with the meat. Because of its superior binding quality, melts (spleen) should be used for the meat portion (50 to 60 per cent) and salt (2 per cent of diet) or dry feed containing the salt should be mixed with the melts while the melts are partially frozen.

The present practice at Leetown is to prepare sufficient diet with sulfamerazine to last for 4 days and to store this at near-freezing temperatures.

If a fish-culturist lacks a balance sufficiently sensitive to weigh out the amounts required, generally he will be able to have this done by a nearby druggist.

A warning should be added of the possibility of harmful results if any other internal medicine is administered during the period of treatment with sulfamerazine.

ACKNOWLEDGMENTS

The writer wishes to thank Dr. Charles M. Mottley, Mr. E. W. Surber, Dr. S. F. Snieszko, and Mr. Roy Furr of the U. S. Fish and Wildlife Service for help

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COMMENTS FROM READERS

We've noticed that our hosts at a steak fry--may those days return--could always depend upon some folks wanting the meat well done and others preferring it rare. The guests never agreed on this point, and apparently they enjoyed the argument almost as much as the steak. (What am I saying!)

Anyhow, let's give the meat of the PROGRESSIVE FISH-CULTURIST the same treatment. Your comments may inspire the other fellow to violent disagreement--but let the juices flow where they may. It's a poor steak that can't stand a little extra seasoning.

INTRUDERS

The carnivorous tiger salamander is common west of the Appalachians, but it is decidedly uncommon and undesirable in hatcheries. Unfortunately, during August 1946 a number of these amphibians appeared in the fish ponds at Valley City (North Dakota) and New London (Minnesota). They reduced the populations of fingerling fish to a very great extent before being themselves eliminated.

ICHTHYOPHTHIRIASIS

IN AUSTRALIAN TROUT HATCHERY

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THE WRITING OF THIS ARTICLE has been inspired by the appearance of a paper by Wolf in the PROGRESSIVE FISH-CULTURIST (1938). Wolf has raised many points, including some questions that are unanswered.

The present author has already described (Butcher, 1941) his own investigation of an outbreak--in fact, two outbreaks--of ichthyophthiriasis, caused by the ciliate protozoan parasite Ichthyophthirius multifiliis Fouquet, at the hatcheries of the Ballarat Fish Acclimatisation Society, Victoria. This was the first occasion on which the disease had attained epidemic proportions in Australia, although there is one previous record of an outbreak in a trout hatchery (Salmon and Fresh Water Fisheries Commission, Tasmania. Report, June 1933). The occurrence of these outbreaks at Ballarat on a particularly large scale in a trout hatchery and the fact that the epidemic was finally brought under control by salt (sodium chloride) treatment, justify the writing of these notes. It is hoped that some

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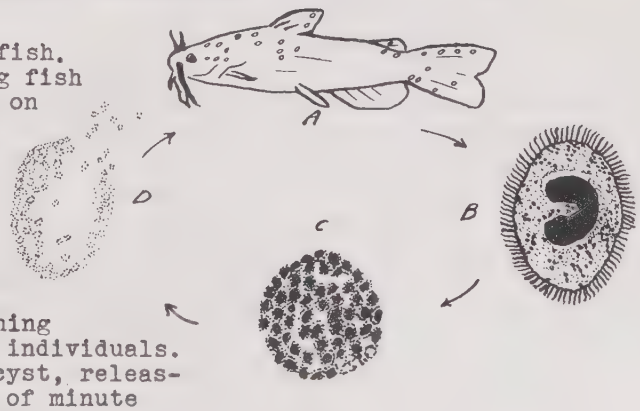
See also:

Fish, F. F.
1935. The protozoan diseases of hatchery fish. Prog. Fish-Cult. 6: 1-4.

Life cycle of Ichthyophthirius multifiliis



A - Adult on catfish.
B - After leaving fish and settling on bottom.
C - Cyst, containing many smaller individuals.
D - Bursting of cyst, releasing hundreds of minute parasites, which reinfect fish.

of the questions Wolf raised will be answered satisfactorily. It should be noted, however, that the prevailing temperatures at Ballarat were somewhat higher than those reported for New York State--and Wolf stresses the importance of temperature.

DESCRIPTION OF EPIDEMICS

In the 1938-39 season the outbreak occurred late in the season and yearling trout, both rainbow and brown, were infected; in the 1939-40 season the epidemic appeared earlier and trout fry, again both rainbow and brown, were infected. The second outbreak occurred because the source of infection was not discovered in the 1938-39 season. It was estimated that fry about 1.5 inches long carried approximately 2,000 parasites. The fish were infected over the body, head, eyes, fins, opercula, and gills, although the gills carried comparatively few parasites.

RELATIVE SUSCEPTIBILITY OF RAINBOW AND BROWN TROUT

This question was not investigated during these outbreaks, but records of losses were kept and these throw some light on the subject. Figures given here are only approximate, as deaths from causes other than ichthyophthiriasis must have occurred, but allowance has been made for these on the basis of records of previous years.

Losses due to ichthyophthiriasis are given in Table 1. In the 1938-39 season

TABLE 1.--Losses due to ichthyophthiriasis[1/]

Season	Brown	Rainbow	Total
1938-39[2/]	198,000	38,000	236,000
1939-40[3/]	275,000	95,000	370,000
Totals	473,000	133,000	606,000

1/ These figures are much higher than those given in the original description of the epidemics (Butcher, 1941), but detailed figures were not available then.
2/ Yearlings.
3/ Fry.

losses due to this disease amounted to 50 per cent among brown trout and 57.4 per cent among rainbows; in the 1939-40 season losses due to this disease amounted to 77.5 per cent among brown trout and 96.2 per cent among rainbows; for the two seasons the average losses due to ichthyophthiriasis amounted to 63.75 per cent for brown trout and 76.8 per cent for rainbow trout. These data indicate that rainbow trout are definitely more susceptible to the parasite Ichthyophthirius multifiliis. It has been the experience of the Ballarat Fish Acclimatisation Society that the percentage losses from all other causes are lower among rainbow trout than among brown trout. Conditions in the hatcheries were practically identical in all the ponds--in fact, as far as the author is aware, conditions were identical--yet there may be some truth in Wolf's suggestion that optimum conditions for rainbow trout may not be maintained in fish hatcheries.

RELATIVE SUSCEPTIBILITY OF TROUT FRY AND TROUT YEARLINGS

Reference to Tables 1 and 2 will give a definite answer to this question.

TABLE 2.--Percentage losses of trout yearlings and trout fry

	Yearlings	Fry
Brown	50.0	77.5
Rainbow	57.4	96.2

Yearling trout were infected in the first season and fry in the second. Trout fry were more susceptible than yearlings to ichthyophthiriasis; this was more marked in the case of rainbow trout. This conclusion is not complicated by any other factors such as are mentioned by Wolf--for example, previous infection, with a mild form of fin rot, of the dorsal fin of some of the rainbow fry; neither species of fish was suffering from any other disease, and all the ponds received water from the same source. In the 1938-39 season the brown yearlings were first affected, and in the 1939-40 season the brown fry first showed symptoms of the disease; on each occasion these fish were the nearest to the source of infection.

TREATMENT OF THE DISEASE

Flowing-water treatment of the disease was not applicable to the outbreak investigated by the present writer. The ponds of the Ballarat hatchery are in series, and no great flow of water can be obtained through them; there is a race at the hatchery, but it is not of sufficient dimensions to accommodate the large numbers of infected fish. Flowing water is an efficient means of dealing with an epidemic and obviously the most economical. It is doubtful that the running water carries away the encysted forms of the parasite as well as those free-swimming forms. Comparatively still water is a prerequisite to encystment, however, and by removing the free-swimming forms a flow of water prevents encystment.

The use of salt (sodium chloride) is the alternative method of treatment. Of course, other chemicals such as mercurochrome and potassium permanganate can be used, but salt is chosen because of its cheapness.

It is useless to attempt to destroy the parasite while it is on its host. Although Wolf states that no investigator has claimed that salt solution will kill parasites imbedded in the skin, his line of attack--treatment with flowing water and intermittent salt baths--would suggest that it was based on some such assumption; that is, that efforts may be made to destroy the parasite while it is on the host by partial chemical treatment.

Whatever method of treatment is followed, consideration of the length of the parasite's life cycle is essential. Various treatments have been condemned because this factor has been overlooked. Every hatchery manager called upon to control an outbreak of ichthyophthiriasis should refer to the available records (summarized by Wolf) showing the relationship between temperature and the length of the life cycle, and apply treatment accordingly. Comparison of the disease

at the New York State Fish Hatchery (Wolf, 1938) and at the Ballarat Fish Hatchery in Victoria (Butcher, 1941) illustrates the necessity for this. According to Wolf, the parasitic stage on the fish lasts from 4 to 5 weeks at a temperature of 52°F. At the Ballarat hatchery, in the epidemic investigated by the present writer, the prevailing temperatures ranged from 60° to 62°F., and the duration of life cycle of the parasite was 14 to 16 days, the parasites remaining on the fish for approximately 11 to 13 days. The same periods for the parasitic stage and for the complete life cycle were obtained under laboratory conditions at similar temperatures. Assuming that temperature is the major factor that determines the length of the life cycle--and this assumption is supported by the fact that life cycles of almost identical duration were obtained at the same temperature under hatchery and laboratory conditions, where trout and carp, respectively, were infected--a difference of 3 weeks in the duration of the parasitic phase is brought about by a temperature variation of 8° to 10°F.

Wolf held infected fish in troughs of swiftly flowing water for 26 days; he gave the infected fish 45-minute baths in 3 per cent salt solution five times during the first 10 days. He also kept fish in two control troughs without salt treatment. As the fish in the control troughs improved at the same rate, within the same period of time, and with no higher mortality than those in salt-treated troughs, Wolf stated that no benefits whatever could be noticed from the use of salt. This conclusion is correct insofar as the method of treatment followed is concerned. The improvement in the condition of the fish was due solely, or almost so, to the flowing-water treatment. Salt treatment, to be beneficial, must be maintained throughout the period of the parasitic phase and preferably for a few days longer as all the parasites may not have infected the host on the same day. Only continuous treatment will destroy all the parasites as they leave the host.

Salt treatment of ichthyophthiriasis can be effective in the destruction of the free-swimming forms and will thus prevent encystment. The present author made exhaustive tests to determine the strength of salt solution necessary to destroy the parasite in its stages away from the host. The results of a few of these tests are given in Table 3. (These results refer only to the stage before encystment.)

At the Ballarat hatchery treatment was given in the ponds and the water supply was cut off as long as possible each day to allow the salt solution to have full effect. A salt solution of approximately 2 per cent concentration was built up in the ponds; no harmful effects on the fish were observed.

As has been pointed out by several authors, the free-swimming forms of the parasite cannot exist in the absence of fish for any great length of time. The present writer (Butcher, 1941) conducted tests to determine whether the cyst of Ichthyophthirius multifiliis could withstand dessication. Cysts were isolated and placed in drops of water and then allowed to dry; they were moistened again on 2 successive days and kept under observation; it was found that cysts could not survive in the absence of water. Thus, as Wolf states, sterilization of ponds that have carried infected fish is unnecessary unless the ponds are to be used again almost immediately.

Sterilization of all gear used in ponds carrying infected fish is essential throughout the duration of the epidemic. Gear includes such articles as nets,

TABLE 3.--Toxicity tests with sodium chloride

Test	Concentration of NaCl.	Number of parasites used	Temperature	Time of cessation of movement		Remarks
	per cent		degrees, F.	Min.,	Sec.	
1	0.5	3	61.3			Still alive after 35 minutes.
2	1.0	3	61.3			Actively swimming 3-5 minutes, then movement ceased. Recovered within 30 minutes.
3	1.5	1	64.4	2	10	No recovery.
4	1.5	1	64.4	4	30	No recovery.
5	2.0	1	64.4	1	45	Observations made 30 minutes later. No recovery.
6	2.0	1	64.4	1	45	Observations made 30 minutes later. No recovery.
7	3.0	4	61.3		12	No recovery.
8	4.0	4	61.3		9	No recovery.
9	5.0	3	61.3		5	No recovery.
10	10.0	5	61.3	Instantaneous.		

dip nets, and brushes. During the outbreak at Ballarat the disease appeared suddenly in the hatching house, which has a separate water supply and is in no way connected with the ponds. Finally it was ascertained that gear used in the ponds had been brought into the hatching house and used there immediately: the parasites had been brought in with the wet gear and had gradually increased in numbers until they were numerous enough to be noticed on the fish. All gear used in the ponds carrying infected fish should be immersed in strong brine solution for a minute or so before being used again.

SPECIES OF FISH INFECTED

There is already an extensive list of species of fish which have been recorded as hosts for Ichthyophthirius multifiliis, and this list is being augmented as the study of fresh-water fisheries progresses. A knowledge of which fish may be infected is of practical importance in hatchery work. In the case of Ballarat, the disease was introduced with infected carp. The following species of Australasian fish, indigenous and non-indigenous, have been reported to be infected with the parasite:

Brown trout	Salmo fario
Rainbow trout	Salmo irideus
Sea trout	Salmo trutta

Carp	Cyprinus auratus
Black fish	Gadopsis marmoratus
Galaxias or Minnow	Galaxias attenuatus
Inangi	Galaxias brevipinnis
Bullies	Gobiomorphus gobioides
Eel	Anguilla australis
Ornamental goldfish and other aquarium fish	

Two more species, pigmy perch (Nannoperca australis) and the tench (Tinca tinca), may be hosts for this parasite, but infection has not been confirmed.

CONCLUSIONS

1. Both rainbow and brown trout are susceptible to attacks of ichthyophthiriasis, but apparently the former species is definitely the more susceptible.

2. Trout fry, both rainbow and brown, are more susceptible than yearlings to this disease.

3. Healthy trout can be infected with ichthyophthiriasis.

4. Treatment of the disease with sodium chloride can be effective if maintained for the full period of the parasitic stage and preferably a little longer. The duration of this phase is controlled largely by the prevailing temperatures.

5. All hatchery gear should be sterilized after being used in ponds carrying infected fish.

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ARTIFICIAL PROPAGATION

OF THOSE CHANNEL CATS

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THE LIFE HISTORY of the channel catfish (Ictalurus punctatus) was studied and the method of artificial propagation of this species was devised by the U. S. Bureau of Fisheries, Fisheries Biological Station, Fairport, Iowa. This species has been successfully reared at a number of fish hatcheries that have followed the Bureau's practices.

In the artificial rearing of channel catfish, pond fish-cultural practice is followed until the eggs have been deposited, after which the open-jar method of incubation has been found advisable, the better to protect the eggs against the danger of being devoured by enemies. The enemies include fishes, the various water animals, etc. The eggs have been hatched very successfully without removal from the nest, but in some instances they have been practically wiped out by enemies. The open-jar plan overcomes this risk and is recommended for this reason.

The number of eggs to the female varies in accordance with its size. A 4-year-old catfish, 10 inches over all, contained approximately 2,000 eggs. A 5-year-old, measuring 12-3/4 inches and weighing 14 ounces, produced 3,100 eggs. A catfish weighing 1-1/2 pounds produced 4,000 eggs, and a 4-pound catfish produced approximately 8,000 eggs. Domesticated female catfish at Fairport, Iowa, did not produce eggs until 4 years old.

Earth ponds cleansed by the elements--sun, wind, freezing throughout the winter (wintered dry)--are best for the rearing of channel catfish. Along the banks of the ponds, 18 inches to 2-1/4 feet below the proposed water line, keg nests are placed, staggered along the pond embankment, preferably at least 10 feet apart. Empty nail kegs placed on their sides have proved more satisfactory than any other type of nest yet tried and are inexpensive. Hardware dealers will usually put them aside and sell them at 10 cents each on request. It is advisable to speak for them some time ahead.

Early work on the artificial propagation of the channel catfish noted in the Report of the Commissioner of Fisheries, 1916: 44-45, and 1917: 84-85.

See also:

Morris, A. G.
1939. Propagation of channel catfish. Prog. Fish-Cult. 44: 23-27.

If food is plentiful for adults, placement of nest may determine quantity of fish per acre. The nail keg should be studded into the side of the embankment in a horizontal position, parallel with the water line, and kept in place by short stakes and a wire over the top. The lower edge of the keg should extend 3 or 4 inches beyond the dirt of the embankment. A quart or two of sand may be placed in the keg, as the sand will aid the male fish in cleansing the keg of all sediment in preparation for the receiving of the eggs. A door may be placed in the side of the keg (the top of the nest when in use) to permit observation when eggs are deposited, but a better way is to observe them through use of a bathing suit. During their time of spawning it is best not to disturb or frighten the fish more than is required for the work.

The channel catfish is normally a current fish. It has been found essential to exercise the brood fish, previous to introducing them into the ponds, in order to condition them for spawning. Exercising the brood fish is a simple matter. An ordinary rearing trough (about 18 feet by 14 inches by 10 inches by 12 inches) or a battery of them as required may be used; through the troughs should pass a strong current of water sufficient to require the brood fish to swim energetically against the current The brood fish should be placed in these troughs 10 days to 2 weeks before spawning time, the period of exercise to commence in accordance with knowledge about the time when the temperature will rise to 75°F. The brood fish should be fed minnows, crawfish, or other live food during the confinement.

To preclude the presence of infertile catfish among the brooders and to pair the parent fish successfully (the male fish cares for and protects the eggs), it is necessary to inspect the brood fish before placing them in the pond. A large belly does not necessarily indicate a female. The sure method is to observe the genitals. It will be observed that the male genital opening has a depressed but nipple-like enlargement, not inflated. The female genital opening will be rounded, bent, soft, often somewhat swollen and inflamed as spawning time nears. If the male genital opening and that immediate region appear thin, puckered, and tight near spawning time, or if the genital opening of the female has a puckered look, such specimens should be rejected as culls and not placed in the pond, as they will not produce and are a menace therein. If the brood catfish are examined carefully in the tubs of water before being placed in the ponds as the water warms to 75°F., any fish-culturist--with a little practice--can easily determine positively the sex of the fish, which will enable him to pair the brood fish properly and reject the culls. Females usually have smaller and more pointed heads. With this method it is not uncommon to obtain a hundred per cent spawning.

The eggs are laid in the keg nest on the bottom (side of the keg) in a glutinous mass, and they remain in this mass, adhered to the bottom, until hatched or removed. Removal may be accomplished by first removing the keg, gently releasing the egg mass by hand, and immersing the egg mass in a tub of water. The egg mass should be handled carefully, and care taken to keep the water in which the transfer is being made at a normal temperature or very slightly below that of the water in the pond. The eggs are sturdy, invariably impregnated thoroughly, and will hatch nearly a hundred per cent if given as careful attention as other fish eggs. Removal of the eggs should be made shortly after they are deposited or after they are eyed in accordance with prevailing conditions. If handled at other stages of development, the greatest care is required to avoid injury to the embryo developing.

The open-top jar such as is used in the hatching of white bass or striped bass is suitable for the hatching of channel catfish. The jar is comparatively flat-bottomed, and one egg mass should be placed in the bottom of each jar. A 3/8-inch rubber tube, leading through a tin shad tube suspended above the eggs from a petcock, admitting a gentle flow of water against the egg mass though not touching it, cleanses and aerates the eggs as would the male fish if they were under his care. Fluctuating temperatures and temperatures much below 75°F., are unfavorable to the eggs and small fry. As the fry yolk sac commences to disappear, the fry may be transferred to the hatching troughs. While they are in the glass jars, they are easily watched and cared for.

Small fry should be handled carefully, and the use of a glass tube about the jars is best for removing the fry. When the fry are placed for rearing, they should not be crowded. The quantity in jars after hatching and later placed in troughs depends on the size of the fry and the space available. Eggs and fry are easily injured by rough surfaces, and nets used for the handling of all fingerlings should be shallow and soft. The fry should not be bunched together, as their barbels pierce the skin of the other fish very easily. Face netting makes excellent covering nets for use in transferring small fish.

The fingerling catfish are best reared in troughs because of the necessity for protection and cleanliness. Where an abundance of water is available, narrow, shallow, creeklike earth ponds may be used but must be kept very clean. The care of the fry and fingerling while in the troughs is exacting. The troughs and fish should be kept scrupulously clean. Careful examination of the fry and fingerlings should be made to guard against gill disease. The channel catfish seem more susceptible to Ichthyophthirius multifiliis than are other species of fish handled. Metal troughs are recommended because wooden or cement troughs cannot be kept so free of bacteria, which become established in the elements that constitute those troughs. Dipping the fish in a carbonate of soda solution (saturated), should Ichthyophthirius multifiliis appear, has been found effective.

The food and feeding of channel catfish held in troughs are very similar to the requirements of trout. Food should be ground fine enough for the fish to take readily, and the food should be screened and fed through a Culler hand-screened feeder or similar feeder in order that food too large for the catfish will not be introduced into the water and so foul it. This plan of feeding is also a food saver, as the attendant observes the quantity of food not being amply ground. Meat diet, such as beef liver, beef hearts, sheep liver, etc., is satisfactory. Cereals are not satisfactory. Fish should be exercised by allowing the water to pass through the troughs at low stage for several hours daily.

As the eggs are deposited and impregnated, they form an oval glutinous mass, the eggs adhering to each other and to the bottom of the keg. The eggs are of golden color, turning pink at the appearance of the embryo. In size the egg mass is about what could be covered by the hand with fingers outstretched and cupped. The eggs are slightly larger than the eggs of the rainbow trout. The incubation period is 8 to 10 days at 75°F. Eye spots appear on the 4th to 5th day.

The fry have light bodies with pink egg sacs. As they grow into fingerlings, they become of a creamy color. This light background becomes dotted with a few black spots during the fingerling second and third stages. These spots continue to increase until the catfish becomes 8 to 11 inches in length and reaches an

age of 1 to 2 years. This size Ictalurus punctatus is known as a "fiddler catfish" along the Mississippi River.

The general color of the fish becomes blue on the back and sides and the spots gradually disappear as the fish becomes 3 to 5 years old and weighs 1 to 3 pounds. During the time Ictalurus punctatus carries the spots and bluish hue, it is known along the Mississippi River as the "channel catfish."

As the Ictalurus punctatus becomes older after the 5th year, his general color becomes a dark blue on the back and sides, his weight increases from 3 to 8 or 10 pounds or more, and he is known as the "blue catfish" along the Mississippi River.

Since the life history of this catfish was worked out by the U. S. Bureau of Fisheries, three species of catfish (fiddler catfish, channel catfish, and blue catfish) have been attributed to this one and same Ictalurus punctatus, which bears different common names at different stages of development because of the periodic changes in coloration.

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the scientific approach

Fremont, Ohio.

The PROGRESSIVE FISH-CULTURIST
Chicago
Illinois

Gentlemen:

We hear that you are starting operations again, and would like to report to you on an important study we have been making at our private hatchery.

As you know, there has been a tendency for people to say that all fishermen are liars. Because of this reputation many people who want to be considered scrupulously honest refuse to go fishing. They cannot take a chance on being called liars. Our problem is to get the public to consider fishermen to be meticulously honest. In working on this problem, we have recently found a solution.

We find that some scales do not weigh accurately. For this reason we now carry three small pocket scales in our tackle box. When a fish is caught we hang the second scale on the first and the third scale on the second, and then hang the fish on the bottom scale. If each scale shows two pounds, the fish, of course, weighs six pounds (2 x 3). By this method we get a very satisfactory weight for the fish, and since three scales were used, there can be no doubt about the accuracy. Even our hatchery fish weigh up to expectation by using this accurate scientific method.

If you could get the fishermen generally to use this system--using three scales instead of just one, we are sure that fishermen would soon be regarded as extremely honest and careful people instead of being referred to as liars.

Yours for greater accuracy,

The Angler's Friend.

Yes, sir--it's tough!

HATCHERY PROBLEMS IN WARTIME

(Name Withheld)

TWO NEGRO SOLDIERS were discussing the relative merits of their company buglers. Said one: "Fellah, when dat boy of ours plays a call, it sounds exactly like the Boston Symphony playing the Rosary." The second soldier snorted, "Brother, you ain't got a bugler. When Snowball Jones wraps his lips around that bugle and plays mess call, I looks down at my beans, and I sez, 'Strawberries, lay still. You is kicking the whipped cream off the plate.'"

Now, if you think you are having trouble, wait until you hear of my difficulties. Before we start these discussions, I should like to pay tribute to our Regional Supervisor. Any person who has heard as many of my troubles as he has, and then requests that they be presented publicly, certainly must thrive on hard luck stories.

In presenting the difficulties we are encountering at this time, I want it understood that what I am about to say is 100 per cent official; it is not an attempt to criticise any person or group of persons; also, that a portion of our handicaps is due to conditions beyond the control of the Fish and Wildlife Service and cannot be expected to improve in the near future.

Undoubtedly, the major portion of our difficulties is traceable to lack of manpower and lack of money, and for my part I have experienced more trouble with manpower than with money. Practically everybody realizes that the dollar has its limitations, but as I see it at this time, there are no limitations as to what can be expected from one human being. From my viewpoint, there is positively no relationship between the amount of work to be accomplished and the amount of labor available for that purpose. In other words, manpower is apparently a very small item when the operation of a fish hatchery is considered.

Evidently most of the Fish Culture project leaders have gone through about the same experience. From 1932 to about 1937, we were an object of charity, seeking aid from the State conservation departments, the WPA, the PWA, the National Youth Administration, the Civilian Conservation Corps; in fact, we sought help from any agency that had plenty of money and nowhere to spend it. Why did the

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Presented at a fish-culturists' meeting during the war period. Since that time the 40-hour work week has appeared.

Bureau of Fisheries fail to secure its part of this huge expenditure for relief purposes? The Forest Service built fish ponds; so did the National Park Service; so did the Tennessee Valley Authority; also the Reclamation Service and various other Federal agencies that had extensive land areas; and we--the very people who were supposed to carry on that phase of the Government's business--had to request the State conservation departments to assist us with distributing the fish produced at Federal hatcheries.

About 1937 we began to recuperate, and we were well on the road to recovery when Pearl Harbor threw this nation into its present conflict. Shortly after the United States declared war on the Axis nations, the employees of our hatcheries began to leave at a very alarming rate. Most of us had an idea that replacements would not be forthcoming in the near future and made some arrangements to meet this labor shortage, but we found it impossible to devise means whereby we could continue to operate on a normal scale with the help that remained.

When the labor shortage became acute in the early part of 1942, it showed poor judgment on my part to think that three persons could perform the same amount of labor that was formerly performed by five, but we had experienced and overcome so many difficulties during the Depression that we were willing to try to carry on with the least possible interruption to the production. With this in view, the Superintendent assisted with the outside work during the regular 8 hours and did the office work at night, on Sundays and holidays. We were apparently getting along all right with the fish-cultural activities, and the general appearance of the station was good; but some reports were not submitted so promptly as required, and as I was usually tired and worn out before starting the office work, a few errors and mistakes began to creep in here and there. Evidently the tardiness and the errors in the clerical work were more than the Service cared to tolerate, and it was not long before I began to get letters that looked as if they had been in a fire. They hadn't; the fireworks were on the inside. Also, the receipt of some hotly worded telegrams showed that we were not getting along so well as we had thought.

When a person is working 10 or 12 hours a day and knows that he is giving the Government 2 or 3 hours a day for which he expects no return, and then he is called on for more work at a quicker pace, that is not very soothing to a tired man's disposition. After considerable meditation we decided that the Service did not want fish, it wanted figures, and as long as the reports were submitted on time, we were apparently in the good graces of various branches of the Service.

Most persons would advance the idea that we should reduce our activities to meet the labor shortage. That suggestion is not worth much if you are going to operate at all. The amount of grass, weeds, and undergrowth in need of attention is not determined by the number of persons available for cutting it down; the elements deteriorate our buildings and structures without requesting information on the number of employees available for repairs; leaves and rubbish accumulate regardless of the labor available for their removal; and experience has taught us that the general public and our administrative officials will not tolerate an untidy appearance, In other words, the station has to make a decent appearance regardless of the other factors. If there is to be a reduction in our activities, there is only one place where this reduction could possibly take place and that is in the fish-cultural section, a reduction in the very phase for which the establishment was built. A fish hatchery that does not produce fish is not a public asset.

Abner Peabody is about the only merchant I ever heard of who would want to reduce his sales in an effort to cut down expenses. Would a transportation company refuse freight available for handling in order to cut down expenses? Would the Western Union Telegraph Company refuse to accept a telegram in order to reduce their expenditures? Would a utility company refuse an applicant electricity because they wanted to reduce expenses? No. These companies were established to serve the general public in their particular field; so were fish hatcheries established to produce fish, and not to submit statistics, afford a place for mowing grass, or remove so much land from taxation.

From the above you can readily see that any reduction for any purpose has to be made in the amount and size of the fish furnished the general public. Regardless of the number of your personnel, there is no explanation that I have found acceptable to the Chicago and Regional Offices for voluntarily reducing the number of reports, etc. I've tried and almost got scalped before getting everything straightened out. I've tried curtailing the amount of attention to our trucks and equipment, and that made the Service Equipment Engineer very unhappy. I've tried curtailing the amount of attention to the general appearance of the station as a whole, and I didn't get any medal for this action either.

Recently a member of the Chicago Office visited our hatchery, and naturally we got a copy of his report. This person was rather extravagant in his criticism of certain phases of our work. One part of this report made mention of the fact that there had been very <u>little improvement</u>--get that, please--<u>improvement</u> in certain phases of our work since the previous inspection trip. Gentlemen, looking for improvements with a very reduced personnel, does not indicate a very clear understanding of what we have to contend with. It would appear that if there had been an understanding of our problems, this person could have at least given us credit for holding our own in spite of a small crew with greatly increased duties. The station was in a disorderly condition, and this untidiness was due to poor judgment on my part. We had either to keep the place in order or collect and ship eggs, and I made the mistake of giving the fish-cultural activities preference. If the general appearance of the station had been good and the tools and appliances properly arranged AND NOT AN EGG IN THE HATCHERY, there would undoubtedly have been a favorable report. As stated before, there are apparently no limitations to what one person can be expected to accomplish, and gradually our fish hatcheries are failing to live up to the purpose for which they were established.

A very great handicap that we have to contend with at this time is the lack of trained personnel for diversified activities. How far would our armed forces be if they tried to combine in one person a dietician, a mechanic, a clerical worker, a purchasing agent, a painter, a plumber, and in odd times a Jack-of-All-Trades? In what condition would our transportation be if the conductor of a freight train had to order his coal, authorize repairs to his equipment, figure out the relationship between amount of fuel used and freight hauled, figure out how much it cost to haul a ton of freight a mile, and then act as agent for the railroad company in trying to settle any claims that might arise from accidents in which his train was involved? Companies that succeed have trained employees for particular jobs, and these companies do not depend on unskilled, underpaid employees for executing workmanship in which skill is necessary.

In advancing an argument to the effect that skilled labor is necessary for success, take the average farmer for example. There is America's Number One Jack-

of-All-Trades. He works hard, he produces, but seldom makes a shining success. The American farmer has had more legislation introduced for his relief than any two or three similar sized groups. You and I belong in the same group as the average farmer, Jack-of-All-Trades, capable of doing a little of almost everything and specialized in none. If you and I were engaged in a commercial enterprise and continued to function under conditions as they are today, we also would be in line for a lot of relief legislation.

Through the courtesy of our Congressman, we receive the Congressional Record, and over a period of a good many years I have followed very closely the proceedings of Congress when their discussions affected the proceedings of our Service and the former Bureau of Fisheries, and over a period of 10 years or more I have never read of any serious criticism of our policies or our work. Some of our lawmakers may be lukewarm, some may be indifferent, but none has appeared to be antagonistic; some have been very outspoken in praising our work and have supported legislation for our benefit. However, when it comes to appropriating money for our purposes, evidently Congress thinks we can get along on very little money.

A very good way to get a clear-cut picture of our work is to compare it with the requirements of other Government agencies. If the War Department used the same tactics as the Fish and Wildlife Service, Eisenhower would not need more than a couple of divisions in western Europe. What would you think of a War Department communique stating that General Eisenhower had lost one-fifth of his men, that the Germans were applying increased pressure, and that our conditions were expected to improve? You would undoubtedly ask how our conditions were going to improve if we had lost one-fifth of our army and the enemy was applying increased pressure. Most of us have lost more than 20 per cent of our personnel, the requirements have increased at least 25 per cent over a period of 5 years, and yet we are expected to carry on business as usual.

Take for instance the labor available for keeping other Government establishments in order. The post office in our town is typical of the post office to be found in any town of five or six thousand people. That building has a fireman and a janitor, whose duties are interchangeable. Their coal is stored by contract; their ashes are hauled away by contract, and their floor space is not in excess of that of our hatchery. We do not have labor available to assign one person to a similar number of tasks.

With all the will power and determination at my command I have tried to adjust my thoughts and my energy toward best serving my employer during these critical times and up to now have not accomplished very much. The greatest obstacle in making a satisfactory adjustment is the apparent desire of the Fish and Wildlife Service to put statistics, reports, and clerical matters ahead of fish production. That was not the case when I entered the Bureau of Fisheries in 1915, and it is hard to teach an old dog new tricks. Our supervisory personnel will tell you that these reports and statistics are necessary for a well-rounded program and in order to answer the inquiries of Congress, the Bureau of the Budget, and the general public. Well, if these reports are so important, why not provide a competent clerical worker for that purpose, instead of depending upon an ex-mechanic, or an ex-truck driver, or a fugitive from the cornfield? Would the Pennsylvania Railroad Company require their section foremen to figure out how much it cost to maintain a mile a year? Would they require their conductors to figure out what it cost to haul a ton of coal a mile? No! For that purpose they

have trained workers who probably know nothing about maintaining the track or the rules of safety in handling a train.

Without doubt, a very large percentage of us have sacrificed a portion of our leave and given generously of overtime in order that our program might carry on with the least possible interruption. For this additional time we shall not receive and do not expect to receive any monetary consideration. For a similar amount of overtime the employees of the Hercules Powder Company, or the General Motors Corporation, or the Kaiser Shipbuilding Corporation would receive several hundred dollars; whereas we may receive an efficiency rating of "very good" or "excellent," which has no trade-in value with the corner grocer or the telephone company, and is not acceptable as part payment on our income taxes by the very Government that issued this rating. In my case it was necessary to work overtime in order that the unit under my supervision might come up to the expectation of our officials. If the Fish and Wildlife Service furnishes us with a $75 chicken coop, our rent goes up about a dollar a month. If we give the Fish and Wildlife Service $100 a year in overtime, we establish a reputation of being a faithful employee.

By giving generously of our services we are temporarily keeping everything moving about on schedule, but to keep this up indefinitely would be no favor to our Service and a gross injustice to ourselves. By tying ourselves down too closely we are losing contact with the outside world; we are getting in a rut; our minds and bodies are tired and not so alert as they should be. We need recreation and diversion and sufficient intercourse with the outside world to keep abreast of the times.

How often have you gone through a large office or plant and had pointed out to you some individual who had been at the same desk or same table for 20 to 25 years and was expected to be working at the same place when time came for retirement? Inquiry will show that he has been efficient to a very high degree; that he has lost very little time and is regarded as the acme of faithfulness by the company, yet he never advanced. Another person who started at the same time with the same qualifications, took his leave, took part in civic affairs, got out and raised a little hell, got a breath of fresh air and was full of vitality--and when there was a promotion, he got it because he had a broader view, was not dog-tired all the time, and could put pep into the business.

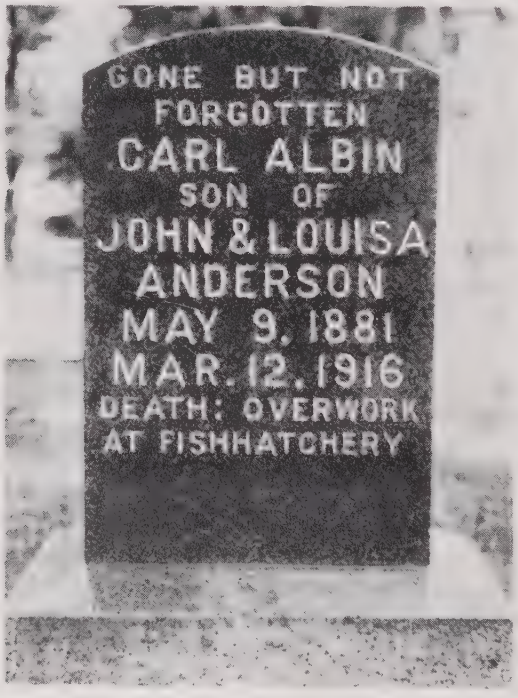
Now with regard to the lack of money: ever since I have been an employee of this Division there was always a tendency to stretch the dollar to the extent that we did not function according to business methods. We always lacked about 10¢ of having a dollar. As a result of trying to cover too much territory, we have been guilty of faulty construction, which means we are continually making repairs, patching up here and there. We buy second-grade materials, use our materials too sparingly, try to raise a lot of fish with a little bit of money. We usually have $10 for repairs but seldom sufficient money to buy new equipment.

We fully realize that the war has not made our path a bed of roses. Our equipment is getting old; competent labor is hard to secure in the small-town garage or repair shop; rationing of gasoline and tires has added to our troubles; the inability of the meat packers to furnish fish food as required is another source of worry; and our inability to determine when this conflict will end is

another factor that gives us considerable concern. However, with all the headaches and problems we have to confront in the proper operation of a combination trout and warm-water hatchery, I should much prefer sweating and swearing in that valley of peace and contentment at home to dodging bullets and wallowing in the mud of France, and I have had experience in both places.

Now to you gentlemen who control our destinies: I suggest that insofar as possible you should give us sufficient labor to carry out your requirements in an orderly and businesslike manner. Please remember that we have as much interest in our individual stations as you have in your Division or your Region. In stating to you that we are operating under difficulties on account of insufficient labor and money, I am well aware of what constitutes an honest productive day's labor by almost any standard; also, as badly as we need it, an increase in salary or an increase in the work week would have no beneficial effect in producing more labor. We are giving you all we have, and the salary of a Cabinet officer could not boost our production. Please give us an opportunity to show you that if provided with sufficient competent labor and a workable amount of funds, we can produce results comparable with any civilian department of this Government.

Now to my fellow workers: may I suggest that without being unduly forward we try to impress on the general public that we are performing work that goes for the betterment of the American way of living; that we are doing something that makes Americans want to live for the enjoyment they get out of living; that we are giving the public something for their money; and above all, let's try to erase that belief that we are just another wart on the Government payroll.



USE OF BENTONITE FOR STOPPING SEEPAGE IN PONDS

Lee M. Duncan
Fish and Wildlife Service
Austin, Texas

UPON MY ARRIVAL at the Inks Dam (Burnet, Texas) Fisheries Station on November 1, 1939, it was discovered that only about 3 acres, of a total pond area of 22 acres, were available for fish-cultural operations. Water was supplied to the pond system by gravity flow through a 14-inch pipe line, the maximum flow totaling 1,100 gallons per minute. All the water available was recuired to maintain a maximum level in four small ponds which comprised an area of 3 acres.

My predecessor at Burnet had informed me that the ponds were losing water through large numbers of cavities created by activity of cut-ants. An inspection tour of the pond area revealed hundreds of active cut-ant dens. There was great variation in the activity of the cut-ants. In some places there was evidence of unusual activity, as several cubic yards of pulverized earth had been brought to the surface and piled in small mounds. Most of the ant dens, however, were much smaller, having not more than a tenth as much fine earth deposited near their entrance.

The first step toward correcting the enormous loss of water from the ponds was to exterminate all cut-ants. This was accomplished by applying carbon bisulphide (CS_2) directly into the entrances of all active ant dens and immediately sealing the openings with a small quantity of portland cement mortar. Incidentally, it was found that if the openings were sealed with mud, this was soon dried and cracked by sun and wind, so that the fumes from the carbon bisulphide escaped into the atmosphere.

After exterminating all cut-ants that could be found on the pond area, the next move was to try "puddling" a small pond (1/2 acre) in order to compact the soil and prevent the water from escaping so rapidly. The pond was drained and a number of mules were driven around and around in the mud for a period of 1 week. At the end of a week the compacting action of these hoofs had reduced the soil to a hard-packed mass. We then refilled the pond. No loss through seepage was

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Report submitted in June 1942.

See also:

Cahn, A. R.
1937. A new and successful method of sealing fish ponds. Prog. Fish-Cult. 29: 12-13.

noted for 3 days, but at the end of this time--when the soil had again become thoroughly saturated--the water loss through seepage was as great as before the "puddling."

After this attempt to reduce seepage by compacting the soil with mules, it was decided that the station could be placed under full production only by treating the ponds with a water-repellent material. Letters of inquiry were addressed to several firms that specialized in the preparation of bentonite for market, and information was obtained regarding the type of bentonite best suited to our needs and the methods of use as practiced by contractors and other Government agencies.

It was decided that the direct method of application was best suited to our needs in impeding loss of water from the ponds through seepage. The fact that the soil to be treated was very fine in texture influenced us to purchase a finely pulverized grade of bentonite.

Before the application of bentonite to the ponds, a small area around each ant den was excavated to a depth of at least 2 feet and then refilled with alternate layers of bentonite and firmly packed earth. This action was taken to prevent water from leaking out of the ponds through the numerous small tunnels which branched out from the ant dens.

The first pond to be treated (No. 10) comprised an area of 8/10 acre. Prior to treatment this pond lost water at the rate of 750 gallons per minute; in other words, this amount of water was required to maintain a maximum water level in the pond.

Before beginning treatment of pond No. 10, it was decided that the usual procedure in applying bentonite would not be satisfactory because of the extremely porous type of soil in this pond. Instead of rolling the pond bottom prior to spreading the water-repellent material, we plowed, disked, and harrowed the soil until the entire pond bottom was thoroughly pulverized. This pulverization was necessary in order to get the bentonite particles (200-mesh grade) uniformly distributed throughout the soil.

The following procedure was used in applying the bentonite:

1. Disked soil, overlapping 50 per cent, cutting 6 inches deep.
   A tractor-drawn tandem disk (with added weight) was used.

2. Harrowed soil with spike-tooth harrow, overlapping 50 per cent.
   Spike-tooth harrow was drawn by caterpillar-type tractor.

3. Plotted pond bottom in squares 10 feet by 10 feet.
   A square wooden frame with two metal-pointed teeth was used to mark the soil in uniform blocks. This marking was necessary in order to gauge the distribution of the bentonite.

4. Distributed the bentonite.
   To avoid waste, the bentonite was dumped into boxes 32 inches long, 20 inches wide, and 6 inches deep. Boxes were constructed with top

boards projecting to form handles for use in moving from place to place. Bentonite (100 pounds to 200 square feet of area or approximately 10 tons per acre) was shoveled from the boxes and carefully spread over the pond bottom. The shovel was moved in a rocking motion to secure even distribution; otherwise, there was a tendency to drop the bentonite in piles. Success in treating hatchery ponds hinges upon the proper distribution of the bentonite.

5. Disked soil (second time)
The tandem disk was set to cut approximately 3 inches deep, overlapping 50 per cent on each circuit of the pond. This second disking served to intermingle the bentonite with the top 3 inches of soil and thereby obtain the maximum benefit of bentonite's swelling properties.

6. Compacted soil after application of bentonite.
A sheepsfoot roller drawn by caterpillar-type tractor was used. Compacting of the soil after application of bentonite prevented displacement of the treated soil, especially near pond supply pipes; action of sheepsfoot roller aided in dispersing the bentonite particles throughout the soil; the compacting action of the sheepsfoot roller occurred below the depth of penetration of the feet. The caterpillar-tractor treads packed the surface.

The results from treatment of pond No. 10 were truly remarkable. After this pond had been treated, it was immediately filled with water and then checked for loss by seepage during a 24-hour period. After treatment the loss of water was only 2 inches in 24 hours; whereas before treatment the loss had been 48 inches during a 24-hour period. In checking water loss from ponds, measurements were made on the pond outlet control structures.

The procedure outlined for pond No. 10 was followed until bentonite had been applied to approximately 15 acres of pond area at the Burnet, Texas, station. Results obtained in treating every pond were entirely satisfactory. Through the application of this water-repellent material the productive area of the station was increased from 3 acres to 22 acres in a period of less than 2 years. The total cost of material and labor for treating the ponds at Burnet amounted to only $2,400. Equally satisfactory results were obtained when this method of applying bentonite was used in treating the ponds at the Austin, Texas, Fisheries Station.

It is believed that in nearly every instance water loss through seepage can be corrected by careful application of bentonite. It is my opinion, however, that each job will require study of soil types and conditions. Texture and other soil conditions will affect the amount of bentonite required, as well as the method of application.

The Service offers neither recommendation nor endorsement, but a list of firms specializing in the preparation of bentonite for market might include:
The Wyodak Chemical Co., 4600 East 71st Street, Cleveland, Ohio.
American Colloid Co., 363 West Superior Street, Chicago, Illinois.
Eastern Clay Products, Incorporated, Eifort, Ohio.

IT PAYS TO GRADE

LARGEMOUTH BASS FINGERLINGS

Hubert C. Topel
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THE PERIODIC GRADING of fingerling fish to reduce cannibalism is a duty familiar to a good many of our fish-culturists. I know from personal experience that the periodic grading of fingerling fish is carried on at a number of our trout and bass rearing stations, but I believe that too much emphasis cannot be placed on this subject. Although we know that the growing trout or bass fingerlings should be graded, there are many adverse factors involved, and we wonder if the grading operations are neglected at times. I believe this is especially true at pond-cultural stations where the draining of ponds during hot weather is a major undertaking, where fertilization is an expensive operation, and the project leader does not want the precious "bugs" to be lost down a drain. Also, the fingerling bass usually need grading during June, when lack of operating funds prevents the hiring of temporary labor and the regular personnel are making spring distributions and trying to hold their own with the weeds at the station.

Despite many handicaps, we believe that grading is a "must" in the rearing of largemouth bass, and we are writing of our experiences at the Tishomingo Station this season as an example. Let me state that this station has the usual problems--serves the entire State of Oklahoma, has 2,500 to 3,000 applications for pondfish each year, has equipment that served throughout the war, shortage of funds for anything except curtailed operation, relies mainly on commercial fertilizer, and so on.

The Tishomingo Station had 243 largemouth black bass brooders to start the 1946 season, and about 50 of these were immature fish. We moved these fish into our holding house, segregated the males from the females, and placed them in two ponds (50 pair to a 2.98-acre pond and 40 pair to a 2.25-acre pond) during the last week of March. The immature fish were held in a separate pond and produced one small hatch of fry. The mature bass started nesting soon after being placed in the ponds, and the first fry were located April 12. During the latter part of April 242,000 bass fry were removed from the two brood ponds and placed in rearing ponds. In addition, it is estimated that more than 150,000 fry remained in these ponds, as we later removed 118,000 1½- to 2-inch fingerlings. Limited acreage made it necessary to place 25,000 bass fry to every acre of the well-fertilized rearing ponds at the station.

Food conditions and the growth rate of the fingerling bass were watched closely in our rearing ponds. When cannibalism became evident, the pond was drained, the fingerlings sorted, and the pond was again fertilized and restocked with small bass of a uniform size. Although every pond drained showed a variation in production, we shall confine our production figures to pond No. 3, as it appears to be almost average for the lot.

Pond No. 3 (1.72 acres of surface area) was stocked with 42,000 largemouth black bass fry (13 pounds 2 ounces) on April 24. This pond was fertilized with 4,000 pounds of barnyard manure April 10, 109 pounds of 12-5-5 (uramon-phosphate-potash) April 15, and 109 pounds of 12-5-5 on April 25. An excellent bloom was evident before the introduction of the fry, and this bloom remained good throughout May. As we planned to drain and restock the pond, no fertilizer was used after April 25 until the pond had been drained. The bloom faded the last of May. We drained the pond June 18 and took from it 24,870 fingerling bass (125 pounds), which were sorted as 21,120 No. 2's (81 pounds) and 3,750 No. 3's (44 pounds). The 3,750 No. 3 fingerlings included more than 400 4- to 5-inch fish and were distributed to applicants. We then changed the size of our sorting box and resorted the 21,120 No. 2 fingerlings. This operation removed 4,120 of the larger fish, the remaining 17,000 being placed in a pond that had previously been filled and fertilized. From these figures it will be noted that we distributed 7,870 of the largest fingerlings from the pond, and we had sufficient bass on hand to stock a 2-acre pond at 8,500 per acre. I believe that 17,000 No. 2 fingerling bass are too many for stocking a 2-acre pond, but the shortage of pond acreage made it necessary. Consideration was given to the even size of the fish, and to the fact that the pond would probably be drained the latter part of August.

For our sorting box we use a simple box constructed of 1 by 4 pine lumber with wood slats evenly spaced on the bottom. This box has been used for a number of years at certain trout stations and can be constructed by anyone in 2 or 3 hours. The important part of construction is in using straight slats and spacing. The slats can be removed and respaced for a different size fish in a very short time, and it has been found that the fingerlings are not injured by this method of sorting. A 10- by 16-inch box can be used to sort 30 to 40 pounds of fingerlings an hour.

Although we have distributed more than 100,000 2- to 4-inch surplus bass fingerlings from our ponds during the 2 months prior to July 15, we expect to have more at draining time this fall than would have been in the ponds had we failed to sort the fish. We realize that cannibalism will develop again in a short period, but we have given our fingerling bass an even break, and it gives us a feeling of satisfaction to know that we are 100,000 to the good. Our draining and sorting operations were conducted in air temperatures between 90 and 106 degrees with no ill effects to the fingerling bass, although it was necessary to move the fish from the ponds to the holding house in the slightly cooler morning temperature.

ENLARGED RICER FOR POND FEEDING

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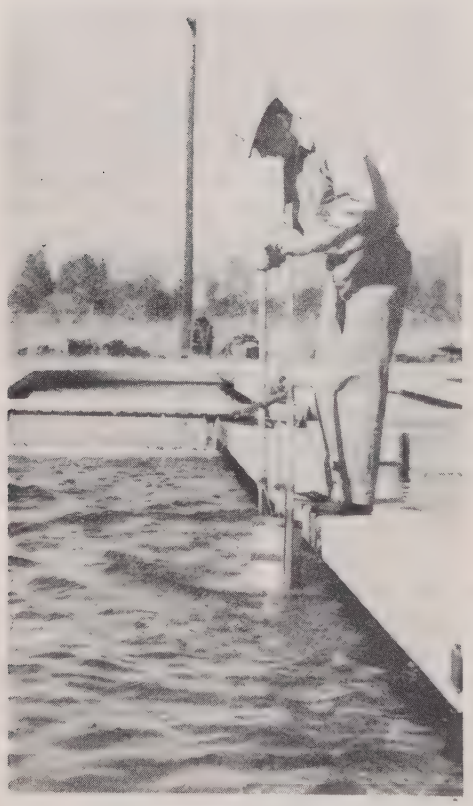

THE POTATO RICER, as originally recommended by Wales (1935) and subsequently modified by Mitchell (1941), has been used successfully for feeding salmon and trout fingerlings in troughs. At best, the potato ricer will hold about three-quarters of a pound of food. With this limited capacity it is obviously an impractical implement for feeding the much larger quantities of food required in the care of rearing ponds. To meet this specific need, a ricer of greater capacity has been developed at the Leavenworth Hatchery. The enlarged ricer is, fundamentally, a manually operated mechanical feeder incorporating the principles of the potato ricer but having a capacity of 10 pounds of food. It was specifically designed for feeding "bound diets" in small and medium-sized rearing ponds.

Bound diets usually are combinations of certain meats and meals which form a rubber-like mass upon the addition of common salt. The high resilience and excellent adhesion of a bound diet make it superior to an unbound diet in that wastage of food is reduced to a minimum. A bound diet does, however, involve certain problems in presenting it in a form that will be readily available to the fish. The principle of ricer feeding (i.e., forcing a bound diet through a perforated plate) solves these problems, but, unless

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See also:

Glenny, F. H.
1938. "The water dissemination method for feeding fish by means of a water distributing pipe line system," Prog. Fish-Cult. 36: 26-29.

mechanical means are employed, it is a physical impossibility to feed large quantities of food in this manner. The long handles and the dog-and-ratchet mechanism of the pond ricer supply the necessary mechanical advantage. The total weight of the pond ricer, when fully loaded, is about 25 pounds--15 pounds being the weight of the ricer itself, and 10 pounds the weight of the food to be fed. As the pond ricer is a two-handled device, the total weight of 25 pounds is not excessive. A working drawing of the component parts is presented in figure 1.

To fill the ricer, the guide latch is released, the movable handle allowed to open to the maximum, and the plunger withdrawn. The desired quantity of food then is placed in the cylinder, the plunger inserted, and the movable handle returned to the guide. During the last operation the movable handle is grasped at its base in such a manner as to include the lever attached to the dog. This procedure automatically clears the dog so that it will not engage the ratchet as the handle is being returned to the guide.

In use, pressure is exerted upon the plunger through the dog and ratchet. Each complete stroke of the movable handle forces the plunger down 1/2 inch, extruding the food through the perforated bottom plate. When the bottom of the cylinder is immersed in water and the ricer is moved back and forth, as in the photograph, the resistance of the water produces a sheering action upon the extruding food. The amount of pressure exerted upon the plunger and the speed with which the ricer is moved through the water, will determine the size of the food particles produced. Continued movement of the ricer, coupled with slight pressure, will produce small particles suitable for feeding 2-inch fingerlings. A slow movement of the ricer, coupled with a heavy pressure, will produce larger particles suitable for fish up to 10 inches in length. By using different variations in these techniques in the operation of the ricer, it is not necessary to vary the diameter of the holes in the bottom plate except for very small fish. For feeding fish up to 2 inches in length, it is suggested that the diameter of the holes in the bottom plate be reduced to 3/32 of an inch and spaced 1/4 inch.

The advantages of the pond ricer may be briefly summarized as follows:

1. The speed with which a pond of fish may be properly fed is materially increased in comparison with other methods. Ten pounds of food consistently were fed in less than 2 minutes per feeding by using a pond ricer. Approximately 10 minutes were required to feed an equal quantity of the same diet by means of a spoon when adequate care was exercised to introduce particles not greater than 1 inch in diameter. Thus, use of the pond ricer reduced by approximately 80 per cent the labor involved in feeding fingerlings in ponds.

2. More efficient utilization of the food is accomplished by ricer feeding than by spoon feeding, presumably through the increase in the quantity of food available to the fish. Records were maintained over a period of 6 months on two comparable lots of pond-reared fish of the same species. The amount of food required to produce a pound of fish employing careful spoon feeding was 4.78 pounds. In the comparable ricer-fed group the amount of food required to produce a pound of fish was only 2.72 pounds, or a reduction of 40 per cent in the cost per pound of fish. Apparently, the loss of the water-soluble components of the diet is the determining factor that reduces

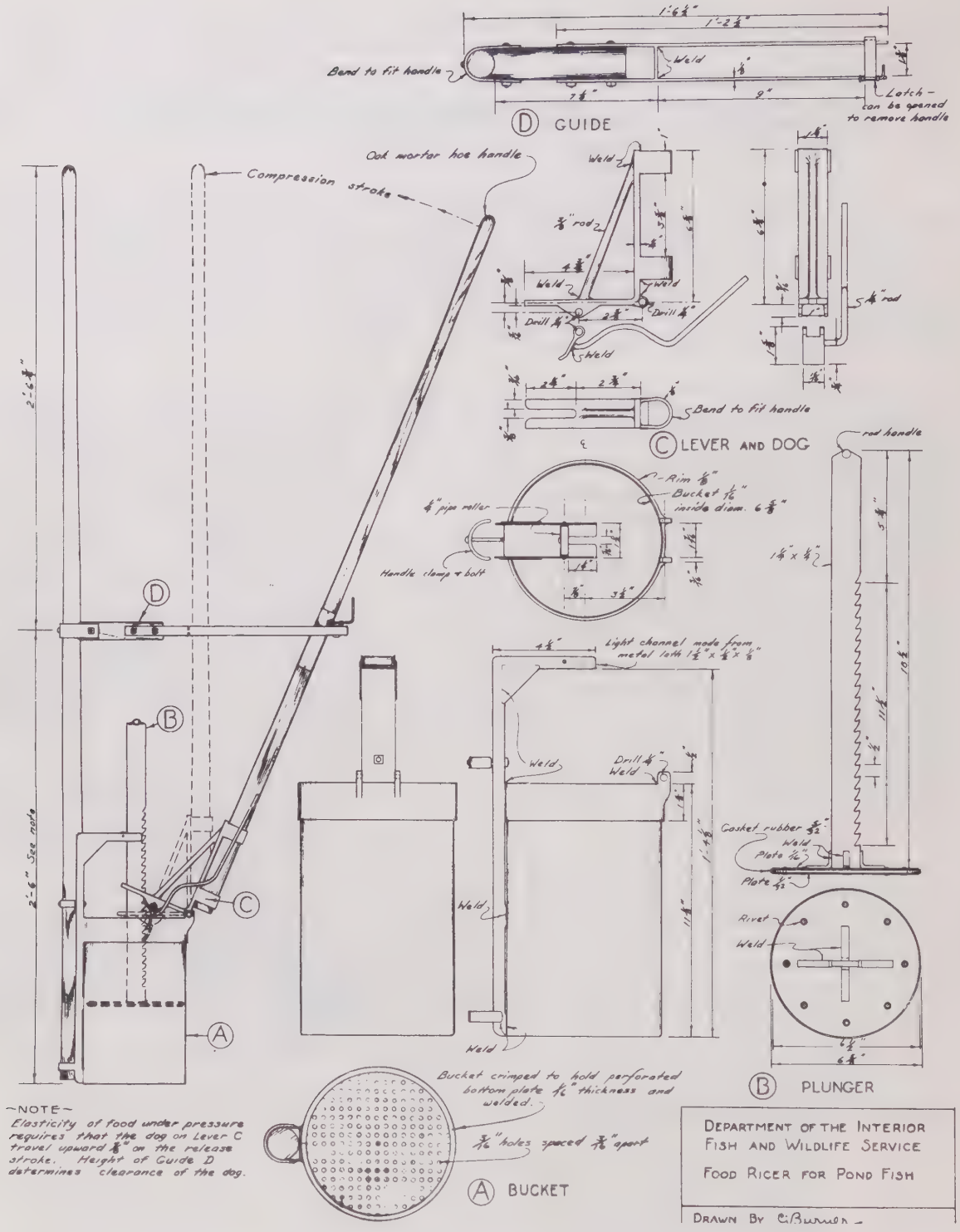
Bend to fit handle
Weld
Latch – can be opened to remove handle
D GUIDE
Oak mortar hoe handle
Compression stroke
Weld
⅜" rod
Drill ¼"
Bend to fit handle
C LEVER AND DOG
rod handle
4" pipe roller
Rim ⅛"
Bucket 1/16" inside diam. 6⅜"
Handle clamp + bolt
Light channel made from metal lath 1½" x ½" x ⅛"
Drill ¼"
Gasket rubber ⅛"
Plate 1/16"
Plate ¼"
Rivet
B PLUNGER
2'-6" See note
Bucket crimped to hold perforated bottom plate 1/16" thickness and welded.
5/16" holes spaced ⅞" apart
A BUCKET
~NOTE~
Elasticity of food under pressure requires that the dog on Lever C travel upward ⅛" on the release stroke. Height of Guide D determines clearance of the dog.
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
FOOD RICER FOR POND FISH
DRAWN BY C. Burner

FIGURE 1.

the conversion, for the ricer-fed fish consumed the same weight of food in one-third the time taken by the spoon-fed group.

Literature Cited

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1941. The potato ricer in the fish hatchery. Prog. Fish-Cult. 55: 28-30.

Wales, J. H.
1935. The feeding of trout in California hatcheries. Trans. Am. Fish. Soc. 65: 305-308.

POSSIBLE NEW RESIDENT OF FARM FISH PONDS

Reports of the Fisheries of Egypt for the years subsequent to 1920 describe the successful transfer of two species of mullet (Mugil cephalus and M. capite) fry from sea water to fresh water, where they provided a profitable 4-year crop totaling 5,910,231 pounds despite the competition of four commercial species of predatory fishes which provided a total catch of more than 34 million pounds in the same period. Likewise, pre-war reports from Japan stated that 1,200 mullet weighing 2,250 pounds were produced in a single acre of water when abundantly fed.

In recent experiments at Beaufort, North Carolina, more than 95 per cent of the very young mullet (M. cephalus) being transferred from sea water to fresh water have survived; apparently all the specimens that died during this operation had been injured by contacts with the fish net and buckets used for collection and transportation. Observing the progress of more than 200 specimens at the Fisheries Laboratory, where they have been growing during the past year in company with several goldfish, 7 mallard ducks, and 40 fresh-water turtles, Dr. H. F. Prytherch of the Fish and Wildlife Service reported that these very fat and lively mullet have increased in length from an average of 3 inches to more than 9 inches, and that the 90 per cent which have survived have made an increase in weight that is equivalent to 2,000 pounds per acre annually.

This is a species that might be given further consideration for use in farm fish ponds in combination with other species.

FISH-SCREEN FASHIONS

New features in fish-screen design are being tested in the Yakima Valley, Washington. J. T. Barnaby, aquatic biologist in the North Pacific Area, Fish and Wildlife Service, reports that to eliminate the excessive wear on drive chains operating under water, a ring gear attached to the end of the screen drum is being tried at two of the projects. Screen drums have been completely redesigned to permit the use of finer screen and closer bottom and side seals.

A NEW TYPE OF DRAIN PLUG

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NECESSITY, WE ARE TOLD, is the mother of invention. The little gadget herein described has no mother, but it does have a dad, a big rough one, represented by the numberless cuss words that many hatcherymen have heaped upon the refractory drain plug that would not stay put while said hatcherymen were attempting to drain and clean a trough of young fry without causing undue damage.

The casualty list of tender fry that have been damaged by being forced into trough tail screens by too swift flow of water through the drain-hole, if calculated separately, would lessen the apparent mortality total by a very gratifying amount. These fry may show up immediately after injury or perhaps not until several days later; but unless the utmost care is exercised in drying the trough, they will show up--injured.

Often even with extreme care it is impossible to adjust the trough plug to permit just the right amount of flow to carry away the waste feed and excrement without drawing the fry or small fingerlings onto the screen. The cussing begins when the plug persists in rearing to "full in" position or pops out entirely.

Having run out of choice expletives and tiring of repeating the same ones, we belatedly tried our hand at correcting the source of the trouble. This "correction" finally took the shape of a combination sheet-metal cylinder and truncated cone, which we promptly saddled with the misnomer, "cleaning plug." We used 28-gauge sheet metal cut to the patterns and assembled as shown in the diagram. This cleaning plug can be made in about an hour if one follows the diagram--and if one is fairly handy with a soldering iron.

The plug that best fills our requirements is of the following dimensions: height, 4-1/2 inches; bottom diameter of truncated cone, 3 inches; diameter of cylinder, 2 inches. The depth of the water should first be determined and the cylinder height then cut to such dimensions that when the plug is placed over the drain-hole, the water at that point will be about 1 inch over the top of the plug. This difference will allow the water to begin draining through the plug,

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The diagram mentioned in this article appears on the last page of this issue.

giving a quick start to the waste and excrement that may be lodged in the upper part of the trough. We experimented with different diameters and found that 2 inches is about the right size; a cylinder of larger diameter drew the water too quickly.

When a cylindrical tube and a truncated cone have been made from the sheet metal, solder one end of the tube to the smaller diameter of the truncated cone. The next operation is to solder four legs (No. 8 nails with the heads clipped) to the bottom of the truncated cone. The legs should be left long enough below the edge of the truncated cone tc permit adjustment to the required height. Adjustable legs can be made by soldering to the sides of the cone four lugs that have been tapped to take 1/8-inch full-thread electrician's bolts. The legs can then be adjusted quickly to any desired height within their range.

A more dressed-up plug can be made by using this cylinder and a section cut from a 3-inch tin funnel, which may be bought for a few cents at any hardware store.

In operation the cleaning plug is placed over the drain-hole. At first, the water will pass down through the tube; after the water lowers to the level of the top of the plug, the remainder will pass under the plug. The amount of water passing under the plug is regulated by clipping the legs until the proper height is obtained. This will depend upon the size of the trough, the amount of intake, etc. When properly adjusted, the plug will allow to pass from the trough only enough water to remove the waste without drawing the fish onto the screen. The object of the truncated cone, or large end, is to permit quick placement of the plug over the drain-hole and eliminate the necessity for "hunting around," as would be necessary if a smaller diameter were used.

We have found this type of plug quite satisfactory also for drawing troughs in which the fish have been salted. We have several plugs for this purpose.

RECENT LEGISLATION FOR CONTROL OF THE SEA LAMPREY

Anglers who have brought in fish scarred by lampreys have been much interested in the progress of H. J. Res. 366, which was signed by President Truman on August 8, 1946. The precise extent of the harm done by lampreys to stocks of lake trout and other species is unknown, but fishermen maintain that 25 to 85 per cent of the lake trout in northern Lakes Huron and Michigan bear scars of previous attacks of this predator-parasite. In the development of control methods, it is, of course, essential to have sufficient knowledge of the natural history (habits, behavior, distribution, habitat, etc.) so that measures may be taken against the lamprey during the most vulnerable stages of its life history. The signing of H. J. Res. 366 opened the way for action in the control of the sea lamprey in the Great Lakes.

CHARLIE M'COFFUS

A field engineer[1] named Charlie McCoffus,
Worked all day in the field and all night in the office,
Checking contracts and vouchers and estimates too,
To be picked all to bits by the Washington[2] Crew.

For the boys in D. C., in their double-lensed specs,
Their sallow complexions and fried collar necks,
Care not for the time nor the money they waste;
If a carbon is missing, a comma misplaced,
They bounce back the paper with ill-concealed jeers,
To harass the hard-working field engineers.

To get back to Charlie, he struggled along,
Till his echoing head told him something was wrong.
He went to the doctor, and "Doctor," said he,
"There's a buzz in my brain. What's the matter with me?"

Well, the medico thumped, as medicos do,
And he tested his pulse and his reflexes, too,
And his head and his heart and his throat and each lung,
And Charlie said, "Ah," and he stuck out his tongue.
Then the doctor said, "God, what a narrow escape!
But a quick operation will put you in shape.

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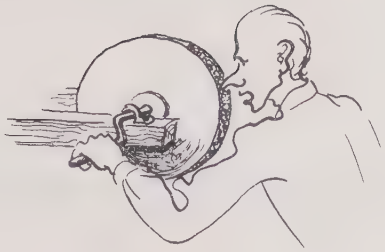
[1]For field engineer substitute fish-culturist, foreman, superintendent, biologist, field agent, etc., as desired.
[2]For Washington, D. C., substitute Chicago or whichever Regional Office may be desired.



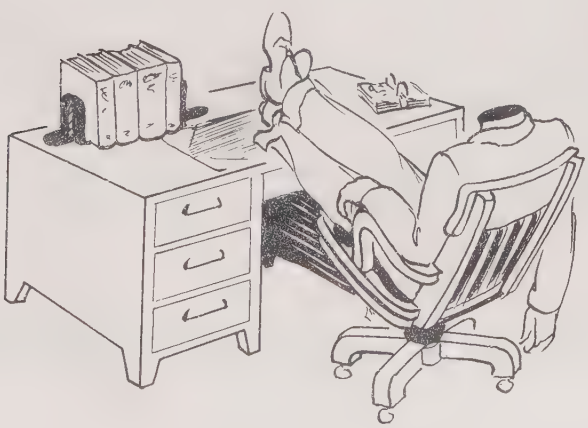
"Your brain's overworked like a motor run down,
And you're flirting with death every time you turn 'round.
I must take out your brain for complete overhauling,
And you, meanwhile, take a rest from your calling."

So Charlie McCoffus went under the knife,
He struggled home brainless and kissed his own wife,
While old Dr. Loomis and two other men
Were putting his brain back in order again.
Well, the weeks rolled along and Charlie McCoffus
Never called for his brain at the medico's office.

The doctor got worried, gave Charlie a ring,
Said, "You'd better come over and get the damned thing."
"Thanks, Doc, I don't need it," said Charlie McCoffus,
"I'm being transferred to the Washington Office."

So Charlie now wears a fried collar to work
And he hides in the lairs where the auditors lurk,
And his letters bring tremors of anger and fear
To the heart of each hard-working field engineer.
And the pride and the joy of the Washington Office
Is the brainless, predaceous Charlie McCoffus.

--Anonymous.



FROM PUBLICATIONS

SUMMARY, CASTLE LAKE TROUT STUDY

J. H. Wales
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California Division of Fish and Game

1. Castle Lake lies about 11 miles southwest of the town of Mt. Shasta in Siskiyou County. It is in the Sacramento River drainage at an elevation of 5,200 feet. It is slightly larger (47 acres) and deeper (maximum 120 feet) than most lakes in the Klamath mountains, but otherwise typical of these small glacial cirque lakes.
2. Castle Lake was chosen for experimentation because of its typical character; because it has a road to it which makes for above average fishing intensity; because it is so located that all anglers can easily be checked; and because it is close to the District Fisheries Headquarters and State Fish Hatchery at Mt. Shasta.
3. The objectives of this investigation were to determine the most suitable species of trout to plant in mountain lakes of this type, the optimum size of fish at planting time, and the optimum number to plant. Three species were used in equal numbers, but the question of the most suitable was obscured by the fact that in a mixed population the success of the component species may be quite unlike their success if they inhabited the lake singly.
4. There is practically no natural propagation of the rainbow, brown and brook trout, and as the hatchery-planted fish were marked it was a simple matter to compute survival rates. All fish planted since 1938 have been recognizable either through marks or their lack, and all catches have been checked from 1941 through 1945.
5. Following are angling figures from 1941 through 1945:

Average number of angler days	580
Average angler days with zero catches	242
Average annual total catch	1,531
Average catch per hour	0.71
Average number of individual anglers	218

Fifty per cent of the annual catch is caught by an average of 13 anglers.

Excerpt from "Castle Lake Trout Investigation, First Phase: Interrelationships of Four Species," which appeared in California Fish and Game, 32 (3): 109-144.

6. Per cent of catch (Average of 1941-45, inclusive):

Rainbow	Brown	Brook	Mackinaw
35%	47%	15%	3%

From 1938 to 1945 the numbers of rainbow, brown and brook planted have been approximately the same. The great differences in the percentages above indicate the dissimilar survival rates of these three species.

7. Pounds of trout caught annually (Average of 1943-45, inclusive):

Rainbow	Brown	Brook	Mackinaw	Total	Average per acre
153	268	32	36	489	10.4

Here we see an even greater difference between the three planted species despite nearly equal numbers stocked.

8. Per cent survival to the anglers:

Of Planted Fingerlings

Rainbow	Brown	Brook
0.5-7.8% Av. 3.5%	5 -9 % Av. 5.5%	0.4-3.2% Av. 1.9%

Of Planted Yearlings

Rainbow	Brown	Brook
39%	35%	40%

The greatest loss, particularly in the fingerlings, is probably due to cannibalism during the first days in the lake. The differences in habits of these species may account for the survival differences. Brooks almost disappear from the catch by the third year after planting; browns play a significant part for five or six years after planting, and thus tend to build up a backlog of older fish; rainbows are intermediate between the other two.

9. From the standpoint of growth it appears that fingerling rainbow, brown and brook can be planted to advantage early in the season while they are still relatively small.

10. From the standpoint of survival it does not appear to make any difference what size the fingerling rainbow and browns are at planting time. However, for the best survival in the brook trout the fingerlings should be as large as possible at planting time.

11. The growth rate of the rainbow in Castle Lake is most rapid, that of the brown is second and the brook third.

12. Approximate maximum ages of Castle Lake trout:

Mackinaw	Brown	Rainbow	Brook
20 years	7-8 years	6 years	3 years

13. The condition factors for the Castle Lake fish are satisfactory and it is possible that the lake could carry more trout.
14. The food preferences of the four species of trout in the lake differ considerably. Marked differences also occur in the various age classes. "Surface" foods play a very important part in the diets of the rainbow, brown and brook but not in the mackinaw. The "bottom" foods are very important to all four species. The plankton and fish eaten vary in volume and frequency of occurrence from species to species and age group to age group. The rainbow eat plankton but almost no fish whereas the brown and mackinaw eat fish but little or no plankton. The rainbow and brook, though displaying some differences, are fairly much alike. The browns are dissimilar and the mackinaw are unique.
15. A test fertilization with soy-bean meal in 1944 (106 lbs. per surface acre) has not appreciably improved the condition or growth rate of the trout.
16. The following costs are for caught fish, both when planted as fingerlings and when planted as yearlings:

Cost Per Fish Caught by Angler

Planted as:	Rainbow	Brown	Brook
Fingerlings--------	$0.30 each	$0.19 each	$0.69 each
Yearlings----------	0.13 each	0.15 each	0.13 each

with a mixed population and consequent heavy predation the brown fingerlings or the rainbow and brook yearlings are the most economical to plant.

17. It seems reasonable to assume that a mixed population such as that which has existed in Castle Lake is not as efficient from the standpoint of trout production as a population of one species. Beginning in 1946 this belief will be tested by stocking with brook trout alone.

Clearing House

As a convenience for those interested in the various phases of fisheries work, the PROGRESSIVE FISH-CULTURIST proposes to list in each issue recent publications on fisheries topics. At present there is no current listing of new and pertinent publications. In order to keep up with new literature relating to their work, men in the field must now depend upon private correspondence, a few tardy abstracts and reviews, and personal contacts. Thus it is suggested that any State, institution, or other source that publishes a bulletin on farm-pond management, fish culture, fisheries research, or other subject of interest to the fisheries field in general, furnish the PROGRESSIVE FISH-CULTURIST with the name of the publication, the name of the author, the source from which copies may be obtained, and, if possible, a copy of the publication.

COLORATION OF FISH

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J. M. Maxwell and A. L. Dorr
U. S. Fish and Wildlife Service

C. M. McCay
Cornell University

In 1916 Prince discussed coloration in fish. He knew that food influenced pigmentation but he also realized that the same food and environment did not cause equal intensity of coloration on all individuals in a school of trout. This fact led him to believe that inheritance was one of the chief factors responsible for coloration. He presented the hypothesis that the colored material in the yolk of the fish egg was passed on to the fry and later appeared in the brilliant colors of the adult. The eggs of wild trout are highly colored and the resulting fish carry the pigmentation. In the case of domesticated trout the eggs have little color and consequently the fingerlings and adults are not greatly pigmented. Prince also pointed out that foods rich in red lipochrome did not color all species of fish, i.e., cod, haddock, and other fish with characteristic pale or white flesh.

In more recent years McCay (1934, 1937) has reviewed this subject. During the interim of these discussions by Prince and McCay considerable work had been presented to show that the lipochromes or carotenoids of an animal's food was chiefly responsible for the pigment laid down in its body or passed on to its products such as milk and eggs. The increased knowledge of vitamin A and its relationship to health in animals was a great stimulant in the study of animal pigmentation. The pigment in the eggs of brown and rainbow trout was found to be closely related to the carotene of carrots. As the trout embryo developed the amount of pigment decreased in the egg and the vitamin A, which is colorless, increased in the fish. This indicated that the trout embryo could transform the egg pigment into vitamin A just as the higher animals convert carotene (MacWalter

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Excerpt from "The Nutrition of Trout," Cortland Hatchery Report No. 11 for the year 1942. (Fish. Res. Bull. No. 4) This hatchery is a cooperative project operated by the New York State Conservation Department, Cornell University, and the Fish and Wildlife Service.

[1]Since December 1945, Assistant Chief, Division of Game-fish and Hatcheries, Fish and Wildlife Service.

and Drummond, 1933).

Biologists and biochemists realize today that several factors are involved in the coloration of fish. These may be grouped into two categories, those of an intrinsic nature, and others extrinsic in character. Students of nature are well aware of the breeding colors, or nuptial coloration, of trout at spawning time. Hatchery trout that have been reared upon a diet of meat and remain drab in color throughout most of their lives become highly colored each year with the approach of spawning. This indicates the effect of sex hormones and the conversion of body stores into pigments.

The influence of hormones on nuptial coloration has received considerable study by Komori (1939) who worked with the Japanese fish Acheilognathus tabira. He found that intramuscular injections of both anterior and posterior pituitary preparations caused pronounced coloration, although the latter was the more potent agent. Bleaching of the nuptial colors occurred following injections of preparations of the adrenal medulla, and other substances, such as acetylcholine and ephedrine. Neither a nuptial coloration nor a bleaching appeared after injections of preparations of the adrenal cortex, pancreas, thyroid, thymus, parathyroid, and vitamins A, B, and C.

Young (1934) reported that injections of intermedin obtained from the intermediate lobe of the hypophysis into the Ohio red-bellied dace caused a rapid appearance of red pigment. Similar work of Zondek and Krohn (1932) showed that injections of this hormone caused a 450 per cent increase in the chloroform soluble pigment of minnows.

Premature spawning in fish has been induced by injections of fish pituitary extracts, but mammalian gonad-stimulating hormones have failed to give satisfactory results in this respect (Koch and Scheuring 1936; Ihering and de Azevedo, 1937; Johnson and Riddle, 1939; Hasler, Meyer, and Field, 1939).

The chromatophores are branched cells which lie in the dermis, or lower part of the skin, and are responsible for the color changes in fish. These specialized cells contain pigment and as the cells are stimulated by hormones and the nervous system a variety of color can be produced. Butcher discussed this phase of coloration in 1936. The two following years he reported upon experiments dealing with the nervous control of pigmentation in Fundulus heteroclitus (Adelmann and Butcher 1937; Butcher and Adelmann 1937; Butcher, 1937, 1938). In 1910 Sumner, who worked with the flounder, stated that the color changes were due to movement of pigment granules within the chromatophores and could be influenced by stimuli received through the eyes of the fish. In 1933 he and Fox reported upon the effect of colored backgrounds on the yellow pigment (xanthophyll) of four species of marine fish and concluded that such stimuli probably could not change the amount of pigment present. Later he fed carotenoids to fish and noted their effect upon coloration.

The hormones and nervous system are the principal intrinsic factors involved in the coloration of fish. Chemicals and food are the chief causes that are extrinsic. Chemicals in the form of fat-soluble dyes have been used to color milk (Huffman and Duncan, 1941), and the yolk of hen's eggs (Gage and Fish, 1924; Denton, 1940). One of these dyes, Sudan III, has been found to color the intestines and mesentery fat of trout but had no effect on the skin (McCay and

Tunison, 1934). The bones of trout may be colored by incorporating the root of the madder plant in their diet (Tunison, et al., 1939).

Fish culturists have found that certain feeds will produce coloration in their trout, but these are few in number. Fresh water shrimp are fairly reliable (Titcomb, 1926; Tulian, 1926). Davis (1937) found that dried salmon eggs and dried haddock roe caused pigmentation in trout. Salmon oil and an alcoholic extract of dried salmon eggs will cause coloration (McCay and Tunison, 1934). These foods contain carotenoids which are responsible for the coloration in the trout. Sumner and Fox (1935) found that carotene and xanthophyll when fed to Fundulus parvipinnis increased the xanthophyll content of the fish. Carotene was apparently converted to xanthophyll. Mann (1936) produced red coloration in Carassius vulgaris by feeding lower crustacea such as daphnia, cyclops, and diatomes. As soon as the fat soluble lipochromes were eliminated from the diet the coloration was checked. The same chemical reactions were given by the red pigments of both the fish and the food, indicating their similarity. Mann also found that the pigments of the carrot were stored by the fish body.

Astacin and astaxanthin are two carotenoids responsible for the coloration in many fish. These pigments are quite widely distributed in nature, but are confined mainly to the animal kingdom and especially to aquatic forms. Although not definitely established they may be present in certain fungi (Lederer, 1934); they are present in certain copepods (Euler, et al., 1934); in crustaceans (Kuhn and Lederer, 1933; Willstaedt, 1934; Karrer and Hubner, 1936; Sorenson, 1936; and Lederer, 1938); in tunicates (Lederer, 1938); in various species of Swedish marine fish (Lonneberg, 1940); in gold fish (Lederer, 1935; 1938) in perch (Lederer, 1938); in the eggs of cod (Emmerie, et al., 1934); in salmon (Emmerie, et al., 1934; Sorensen, 1933; Bailey, 1937); and in trout (Sorensen and Stene, 1939).

Kuhn, Stene, and Sorensen (1939) have summarized the distribution of astaxanthin in the animal and plant kingdoms. These workers believe that the coloring matter of the crustaceans are all derivatives of this carotenoid (Kuhn and Sorensen, 1938). They have reported upon the chemical differences between astacin and astaxanthin (1938). Astaxanthin, $C_{40}H_{52}O_4$, is 5, 5'-dihydroxy-4, 4'-diketo-β-carotene. Sorensen (1935) states astacin, $C_{40}H_{48}O_4$, to be 4, 5, 4', 5'-tetraketo-β-carotene. Some birds are able to synthesize astaxanthin from other carotenoids (Kuhn, Stene, and Sorensen, 1939) and the question arises whether or not this same synthesis occurs in hatchery trout at spawning time.

During the past year feeding trials were conducted with Herring Gull eggs to test their value as a fish food. Diets Nos. 650, 652, and 653 were employed in these experiments ... Coloration on the brook trout fingerlings receiving these diets was observed as early as two weeks after the diets were started, and it gradually increased in intensity thereafter until the trout resembled wild fish.

Extracts were prepared from the gull eggs in an attempt to isolate the carotenoid responsible for this coloration. Various solvents and methods of isolation were tried and the one chosen as being the most satisfactory for this work was carried out in the following manner. The eggs were cooked in a double boiler and broken up by means of a potato ricer. 300 grams were extracted with 500 cc. of boiling acetone. The eggs and acetone were transferred to a piece of muslin cloth, the liquid being then squeezed through the cloth. The eggs were re-extracted with

an additional 200 cc. of boiling acetone. After cooling, the combined acetone extracts were transferred to a separatory funnel and extracted with about one half their volume of petroleum ether. Only one extraction was made since this removed nearly all of the color. The ether fraction was washed with distilled water several times and finally transferred to a liter Erlenmeyer flask. The astacin or astaxanthin was removed from the ether solution by shaking it with successive portions of talc, using in all 150-200 grams of the adsorbent. The talc became violet-pink in color. It was washed with petroleum ether until the washings were clear. The pigment was eluted from the talc with 95% ethyl alcohol. The alcohol was evaporated at room temperature to a low volume and finally taken up and thoroughly mixed with dry feed mixture No. 12 ... This was called fraction I. After treatment with the talc the petroleum ether solution was evaporated to a low volume at room temperature and finally taken up on No. 12 dry feed mixture. This was called fraction II.

The dry feed mixtures containing fractions I and II were mixed with an equal weight of fresh pork spleen and fed to two groups of brook trout fingerlings averaging about four inches in length. After a period of eight weeks those fish receiving fraction I had developed the characteristic red color of wild fish in their ventral and anal fins, and the red spots appeared on the sides of the body. This coloration was not as intense as that on a control group of trout fed 100 per cent gull eggs however. The group of fish receiving fraction II did not develop any color.

The absorption curve[1] was obtained for the pigment which was absorbed by the talc. It was eluted with 95 per cent ethyl alcohol and the solution read in a Bausch and Lomb medium quartz spectrophotometer. The curve had an absorption peak at 475 mμ. This observation and the chemical characteristics exhibited during the course of extraction by this carotenoid leads us to believe that it is either astacin or astaxanthin, probably the latter.

Sources of astacin and astaxanthin are confined mainly to the aquatic forms of fish food such as shrimp. Such food is limited on the market and rather expensive. Fish culturists desire to rear their trout to resemble those of the wild in coloration and a cheap plant-source of fish food causing such pigmentation would be advantageous. Pimiento pepper has been fed to poultry in the South to color the yolks of eggs (Brown, 1930, 1934). The pepper contains the carotenoid capsanthin, $C_{40}H_{58}O_3$, (Brown, 1935) which is responsible for the yolk pigmentation. Capsanthin is also found in paprika (Zechmeister and Cholnoky, 1934). Paprika was fed to trout to determine its pigmenting properties. The diet consisted of paprika--12.5 parts, dry feed mixture No. 12--37.5 parts, and fresh pork spleen--50 parts. It was found that this feed colored the trout as well as did the diet of 100 per cent cooked gull eggs. The shades of color were not identical but it would be difficult to distinguish these fish from those taken from the wild as far as external coloration was concerned. The flesh of the trout did not color whether fed the gull eggs or the paprika but this might have occurred had the diet been continued for a longer period of time. Smaller amounts of the paprika would perhaps suffice since only 0.5 lbs. are used in 100 lbs. of poultry ration for the purpose of yolk coloration.

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[1]We are indebted to Dr. Henry Paul of the Norwich Pharmacal Company for making the absorption readings.

Several other feedstuffs used in the practical diets this year caused pigmentation in the trout although none were as potent as the two mentioned above. Diets containing smelt caused a slight red coloration of the spots on the sides of the fish body indicating that this species of fish contains astacin or astaxanthin. Corn gluten meal, alfalfa leaf meal, and dried hen's eggs when incorporated in diets caused a yellow pigmentation in brook trout. The carotenoid responsible for this would probably be xanthophyll.

In all groups of fish in which pigmentation occurred there are considerable individual variation in the degree of coloration produced. As mentioned earlier this may be influenced by hereditary characteristics. It may also possibly be related to some vitamin factor, such as the anti-grey hair factor needed by rats, silver foxes, and dogs for the maintenance of a normal black color in their fur.

The pigmentation that occurs in fish is interesting since such studies may furnish valuable information on their requirements for vitamin A. The two are related and little is known concerning the requirements of this vitamin by these vertebrates.

* * *

Dry Feed Mixture No. 12:	Cottonseed Meal	24
	Wheat Flour Middlings	24
	Dried Skim Milk, Roller Process	24
	White Fish Meal	24
	Salt	4

* * *

Diet No. 650:	Pork Spleen	50
	Dry Feed Mixture No. 12	25
	Raw Herring Gull Eggs	25
Diet No. 652:	Pork Spleen	50
	Dry Feed Mixture No. 12	25
	Cooked Herring Gull Eggs	25
Diet No. 653:	Pork Spleen	73
	Salt	2
	Cooked Herring Gull Eggs	25

* * *

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Excerpts from Further Studies on Same Subject

THE NUTRITION OF TROUT: Cortland Hatchery Report No. 13 for the year 1944
A. V. Tunison, A. M. Phillips, H. B. Shaffer, J. M. Maxwell, D. R. Brockway, and C. M. McCay
Fish. Res. Bull. No. 6, New York State Conservation Department, Albany, N. Y.

Brook trout were colored by means of paprika in the diet. Of the various levels tried, 2 per cent appeared to be the optimum from the standpoint of color produced and cost. At this level coloration occurred within four to six weeks and gradually increased in intensity with time. Levels of 10 per cent which produced brilliant coloration, were not toxic over a 24-week period.

THE NUTRITION OF TROUT: Cortland Hatchery Report No. 14 for the Year 1945
A. M. Phillips, A. V. Tunison, H. B. Shaffer, G. K. White, M. W. Sullivan, Curtis Vincent, D. R. Brockway, and C. M. McCay
Fish. Res. Bull. No. 7, New York State Conservation Department, Albany, N. Y.

Paprika caused marked coloration in brook trout in a short period. Brown trout were slightly colored over a much longer period and rainbow trout showed little or no coloration. There appears a species difference in the ability of paprika to cause coloration in trout.

Abstracts

Transactions, American Fisheries Society

Through the courtesy of Dr. Russell P. Hunter (Secretary) and Dr. Ralph Hile (Chairman of the Committee on Publications), the following abstracts of papers presented at the 76th Annual Meeting of the American Fisheries Society have been made available for publication in the PROGRESSIVE FISH-CULTURIST:

RELATION OF DISSOLVED OXYGEN TO WINTER MORTALITY OF FISH IN MICHIGAN LAKES

Gerald P. Cooper and George N. Washburn
Michigan Department of Conservation
Ann Arbor, Michigan

Winterkills of fish in southern Michigan lakes during 1944-45 provided an opportunity to study the effect of different degrees of oxygen depletion on the extent of mortality and survival of several common species of fish. Eleven lakes were considered. Several inches of snow cover remained on the lakes from December 11 to February 15. This abnormal persistence of snow cover was accompanied by oxygen depletion in some of the lakes, midwinter lows occurring about February 14. The maximum concentration of oxygen in vertical series taken at about the time of greatest depletion ranged from 0.2 to above 5.0 p.p.m. in the different lakes. Where oxygen depletion was severe, this maximum occurred only in a thin stratum immediately beneath the ice. Heavy winterkills occurred only in those lakes wherein the dissolved oxygen was depleted to approximately 0.65 p.p.m. or less. The mortality was greatest among bluegills and largemouth bass, apparently 100 per cent in some lakes. Among the pumpkinseeds, mud pickerel, northern pike, chub suckers, bullheads, and golden shiners there was a large rate of survival even in lakes where the oxygen was reduced to 0.3 and 0.2 p.p.m. No instance of a complete kill of all fish in a lake was encountered.

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STANDARDIZATION OF METHODS OF EXPRESSING THE LENGTHS AND WEIGHTS OF FISH

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Fishery workers in the United States and Canada are unable to think readily in terms of the metric system of weights and measurements. Even long experience does not make it possible to form a clear idea as to the actual size of fish for which lengths and weights are given in metric units, without first converting to the English system. A more general adoption of the English system of weights and measurements in fishery work is accordingly recommended. The use of English units exclusively is suggested for articles of a popular or semipopular nature, but in more formal publications the key information, at least, should be recorded in both systems. In highly technical papers metric units alone may prove satisfactory.

Eight standard lengths, the fork length, and two total lengths of fish have been employed in fishery work. Although the standard length, under one or another of its several definitions, has enjoyed the widest use in the past, opinion is well-nigh unanimous today that we should turn to some other measurement. Agreement is lacking, however, as to which length measurement is suited best for uniform adoption. The total length is recommended here for the reason that it is the only measurement that includes all of the fish. This length is defined as the distance from tip of the head to the tip of the tail with the lobes compressed so as to give the maximum measurement.

Problems of standardization are by no means confined to the expression of lengths and weights. A greater uniformity in terminology and procedure would facilitate notably the exchange of information and the ready interpretation of data in almost every phase of fishery work.

THE EFFECTS OF DEFLECTORS IN A SECTION OF A MICHIGAN TROUT STREAM

David S. Shetter, O. H. Clark, and Albert S. Hazzard
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Ann Arbor, Michigan

The pertinent literature is reviewed, and defects in previous research along this line are pointed out. The general stream characteristics of Hunt Creek, Montmorency County, Michigan, are described, and three large-scale maps of Section B, the stream section improved, are included. Methods used in the stream mapping, population study, bottom-food research, and intensive creel census are given.

The data obtained indicate that installation of 24 pool-forming deflectors in 1,605 feet of Section B in September 1941 increased the number of pools from 9 to 29, increased the average pool depth by approximately 6 inches, exposed additional gravel, and stabilized silt and sand bars. Bottom scouring and deposition took place locally, as there was no significant change in the average depth of

the entire section nor was there any significant change in total stream area.

Following placement of the deflectors, bottom-food studies indicated a decrease in total number and volume of organisms, but an increase in forms known to be favored by the brook trout (Salvelinus f. fontinalis Mitchill). Population studies before and after the installation of improvement devices demonstrated a slight increase in the total brook trout population, in the muddler (Cottus b. bairdii) population, and in the minnow population, but a decrease in the crayfish (Cambarus sp.) population. Average creel-census figures for a 3-year period before and a 5-year period following the placement of the improvement devices show the following improvements in the angling: 120 per cent in total catch; 141 per cent in total pounds caught; 35 per cent in number caught per hour; 46 per cent in pounds caught per hour; in spite of an increase of 64 per cent in angling pressure (hours). The number of unsuccessful anglers decreased 25 per cent after improvement. It is concluded that the improvement in brook trout fishing in Section B is due to the increase in number, size, and depth of pools formed by the deflectors installed there.

EXPERIMENTS WITH COMBINATIONS OF LARGEMOUTH BASS, BLUEGILLS, AND MINNOWS IN PONDS

H. S. Swingle
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Various combinations of largemouth bass, bluegills, golden shiners, gizzard shad, and Gambusia were stocked in 0.25-acre experimental ponds. The ponds were fertilized with inorganic fertilizer. After 1 or 2 years the ponds were drained and the fish counted and weighed.

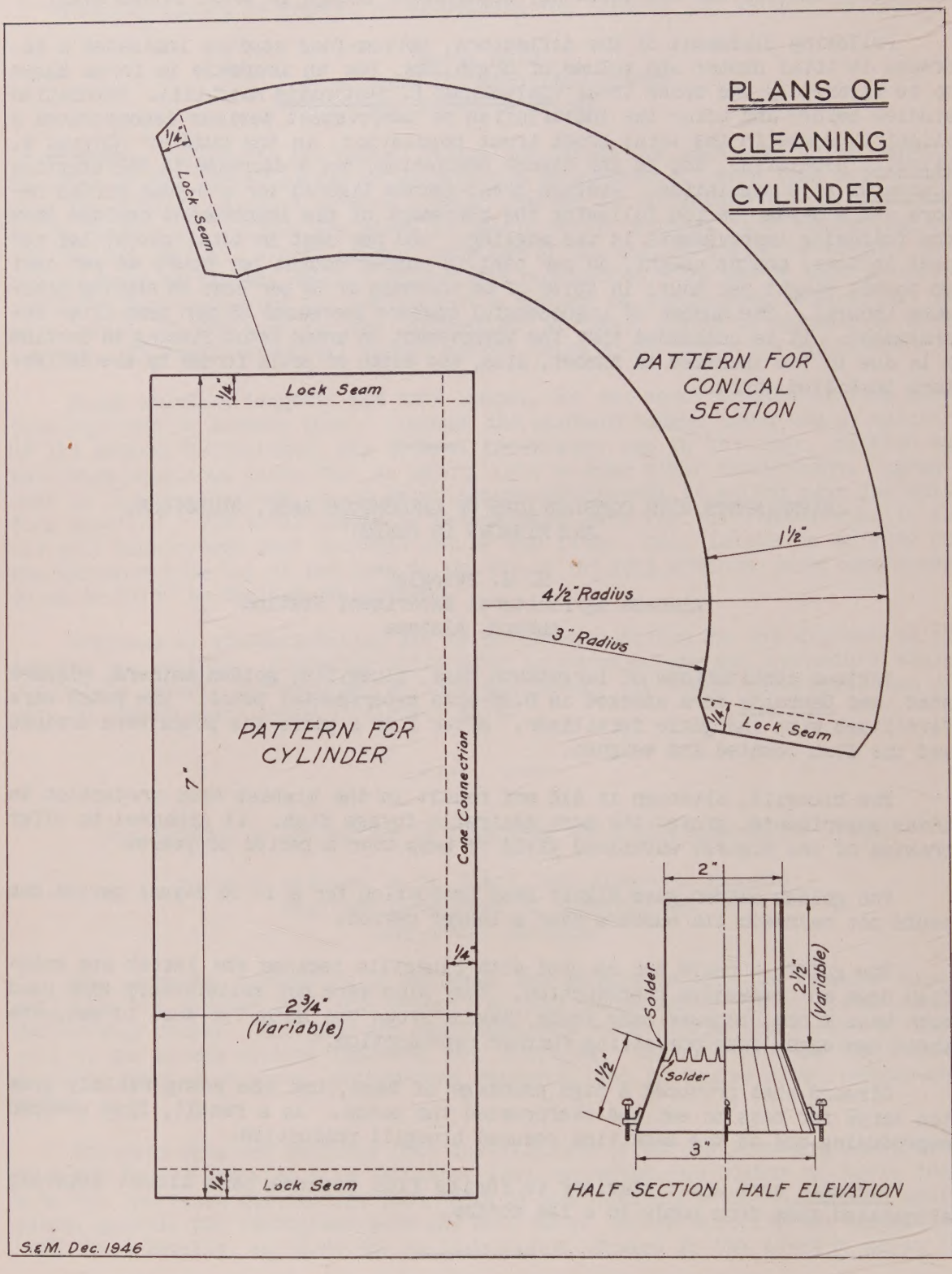
The bluegill, although it did not result in the highest bass production in these experiments, proved the most desirable forage fish. It appeared to offer promise of the highest sustained yield of bass over a period of years.

The golden shiner gave higher bass production for a 1- to 2-year period but could not maintain its numbers over a longer period.

The goldfish could not be used with bluegills because the latter ate goldfish eggs and prevented reproduction. They also were not satisfactory when used with bass alone, because many young, having grown too large for bass to eat, ate their own eggs, thus preventing further reproduction.

Gizzard shad produced a high poundage of bass, but the young rapidly grew too large for bass to eat and overcrowded the ponds. As a result, they stopped reproducing and at the same time reduced bluegill production.

Gambusia were unsatisfactory as forage fish because bass almost entirely eliminated them from ponds in a few months.



Patterns are drawn to scale. For heights other than the one shown, it will be necessary merely to change the "variable" dimension to suit. The 7-inch dimension remains constant for all 2-inch diameter cylinders. The patterns provide for ample material for lock seams and soldering joint.

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